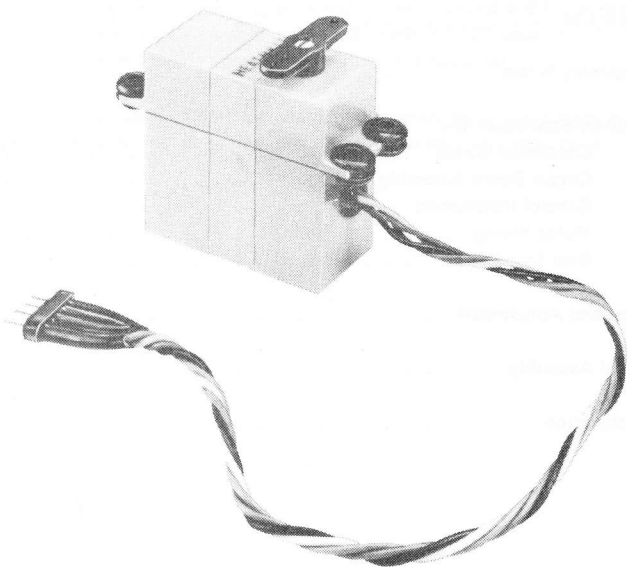


Assembly and Operation
of the



**SUBMINIATURE
DIGITAL PROPORTIONAL
SERVO**

MODEL GDA-19-42



HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

PARTS LIST

Check each part against the following list. The key numbers correspond to the Parts Pictorial (fold-out from Page 7).

To order replacement parts, refer to the "Price Each" column and use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" in the "Kit Builders Guide."

KEY PART	PARTS	DESCRIPTION	PRICE
<u>No.</u> <u>No.</u>	<u>Per Kit</u>		<u>Each</u>

RESISTORS

1/4-Watt

A1	1-4-12	1	2200 Ω (red-red-red)	.10
A1	1-9-12	1	10 k Ω (brown-black-orange)	.10
A1	1-94-12	1	18 k Ω (brown-gray-orange)	.10
A1	1-93-12	2	330 k Ω (orange-orange-yellow)	.10

Precision

A2	2-34-12	1	15 k Ω	1.75
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KEY PART	PARTS	DESCRIPTION	PRICE
<u>No.</u> <u>No.</u>	<u>Per Kit</u>		<u>Each</u>

CAPACITORS

B1	21-94	1	.05 μ F disc	.15
B2	21-175	1	.001 μ F ceramic (brown-black-red)	.45
B3	25-211	2	33 μ F tantalum	.85
B3	25-255	1	.22 μ F tantalum (R22 μ F)	1.10
B3	25-256	2	.47 μ F tantalum (R47 μ F)	.60



KEY PART	PARTS	DESCRIPTION	PRICE
No.	No.	Per Kit	Each

TRANSISTORS-INTEGRATED CIRCUIT-DIODES

NOTE: Transistors are marked for identification in one of the following four ways:

1. Part number.
2. Transistor type number.
3. Part number with a transistor type number.
4. Part number with a transistor type number other than the one listed.

C1	417-267	1	MPS6560 transistor	.65
C1	417-268	1	MPS6562 transistor	.70
C2	443-75	1	Integrated circuit	5.50
C3	56-56	2	1N4149 silicon diode	.20
C4	56-74	1	MZ2362 compensating diode	.65

WIRE-SLEEVING

NOTE: For wire and sleeving, the price is per foot.

	340-3	1	Bare wire	.05
	344-125	1	Black wire	.05
	344-127	1	Red wire	.05
	344-130	1	Green wire	.05
	344-134	1	White wire	.05
	346-1	1	Sleeving	.05

KEY PART	PARTS	DESCRIPTION	PRICE
No.	No.	Per Kit	Each

HARDWARE

D1	250-1123	5	1-72 x 1/8" screw (one extra)	.05
D2	250-82	4	#4 x 1/2" wood screw	.05
D3	259-2	1	#8 solder lug	.05
D4	238-1	1	3/8" gear pin	.10
D5	238-29	1	Control drive shaft	.60

MOLDED NYLON PARTS

E1	238-19	1	Idler gear marked #1	.45
E2	238-20	1	Idler gear marked #2	.45
E3	238-21	1	Idler gear marked #3	.45
E4	238-18	1	Rotary drive gear	.45
E5	238-22	1	Rotary output wheel	.35
E6	238-23	1	Rotary output offset arm	.35
E7	238-24	1	Rotary output large arm	.35
E8	238-25	1	Rotary output small arm	.35
E9	238-26	1	Case bottom section	1.05
E10	238-27	1	Case center section	1.35
E11	238-28	1	Case top section	1.35



KEY PART		PARTS	DESCRIPTION	PRICE	KEY PART		PARTS	DESCRIPTION	PRICE
No.	No.	Per Kit		Each	No.	No.	Per Kit		Each
MISCELLANEOUS					Miscellaneous (cont'd.)				
F1	9-40	1	1500 Ω control	1.65		391-34	1	Blue and white label	
F2	73-64	1	Foam gasket	.25		597-260	1	Parts Order Form	
F3	73-53	1	Small rubber grommet	.10		597-308	1	Kit Builders Guide Manual (See front cover for part number.)	2.00
F3	73-100	4	Large rubber grommet	.10				Solder (Additional 3' rolls of solder, #331-6, can be ordered for 15 cents each.)	
	85-511	1	Circuit board	.25					
F4	238-30	1	Control wiper	.75					
F5	420-74	1	Motor	5.00					
F6	432-104	1	4-pin male connector	.70					
F7	390-360	6	Clear "Heathkit" label	.10					

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

TEST AND ADJUSTMENT

The following adjustments are only for the Servo. Do not attempt these adjustments unless the transmitter has been completely adjusted with a servo according to the instructions in your transmitter manual.

If the Servo does not operate as described, refer to the "In Case of Difficulty" section on Page 28.

CENTERING

Refer to Figure 3 for the following steps.

- () Connect the Servo to channel #1 of the receiver.
- () Turn the transmitter on. Be sure the channel #1 trim tab is in its center position.
- () Turn the receiver battery switch on. The Servo may start to run and then stop. This is normal.
- () Move the transmitter channel #1 stick in one direction and then the other. The Servo should move, stop, and reverse direction according to the stick position.
- () Release the stick.

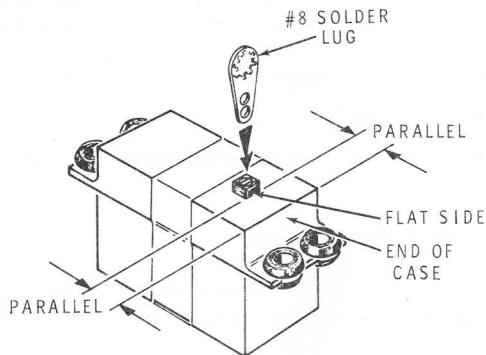


Figure 4

Refer to Figure 4 for the following steps.

NOTE: If the flat side on the rotary output post is parallel to the end of the case as shown, disregard the following step and proceed to the "Travel" section.

- () Adjust the control drive shaft in the rotary output post with the #8 solder lug or a small screwdriver until the flat side on the rotary output post is parallel to the end of the case.

NOTE: As you turn the shaft, the rotary output post will turn in the opposite direction. It may be necessary to repeat this adjustment several times to get the rotary output post properly positioned.

TRAVEL

Refer to Figure 5 for the following steps.

- () Push the large rotary output arm onto the rotary output post.
- () Move the transmitter channel #1 trim tab to one end and then the other while operating its stick through its entire range. Check to be sure that the center line on the output arm does not go past the corners of the case.

NOTE: If the rotary output travel is not proper, refer to your transmitter manual for proper transmitter adjustments.

- () Check the Servo to be sure it is running smoothly and is not binding. Binding will cause excessive current drain on the battery.
- () To ensure proper operation of the Servo, a 2 to 5 minute break-in period is recommended. Use your system to run the Servo from end-to-end.
- () Turn the transmitter and receiver off.

This completes the "Test and Adjustment" section. Proceed to the "Final Assembly" section.

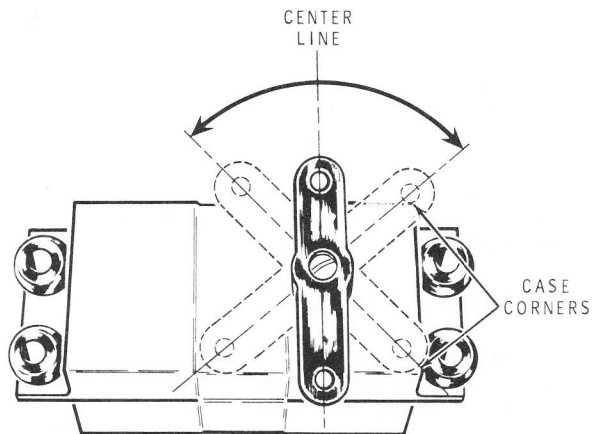


Figure 5


Troubleshooting Chart

CONDITION	POSSIBLE CAUSE
Servo completely dead.	<ol style="list-style-type: none"><li data-bbox="711 267 889 288">1. Dead battery.<li data-bbox="711 322 997 370">2. Faulty connections or miswired servo connector.<li data-bbox="711 405 984 477">3. Transistors Q1 and Q2 interchanged or installed backwards.<li data-bbox="711 511 1029 560">4. Solder or wire bridges around the leads of the IC.<li data-bbox="711 594 1024 643">5. Check for proper component installation.
Servo travels to one end and stays there.	<ol style="list-style-type: none"><li data-bbox="711 698 948 718">1. Transistor Q1 or Q2.<li data-bbox="711 753 987 773">2. Control R7 wired wrong.<li data-bbox="711 808 943 828">3. Motor wired wrong.<li data-bbox="711 862 954 883">4. Resistors R2 and R3.

CONDITION	POSSIBLE CAUSE
Servo operates in only one direction.	<ol style="list-style-type: none"><li data-bbox="773 179 1020 199">1. Transistor Q1 or Q2.<li data-bbox="773 236 1037 256">2. Capacitors C1 and C2.<li data-bbox="773 293 1020 313">3. Resistors R2 and R3.
Servo unstable (hunts or chatters).	<ol style="list-style-type: none"><li data-bbox="773 350 1078 370">1. Capacitors C3, C5, and C6.<li data-bbox="773 407 1070 427">2. Resistors R1, R5, and R6.
Servo slow (sluggish) low power.	<ol style="list-style-type: none"><li data-bbox="773 464 1037 484">1. The gear train binding.<li data-bbox="773 515 954 536">2. Weak battery.<li data-bbox="773 567 1029 588">3. Diode D1, D2, or D3.<li data-bbox="773 619 946 640">4. Resistor R4.
<p data-bbox="277 707 1428 754">NOTE: The IC has been pretested and should not be an initial source of a problem. However a defective IC can cause any of the above conditions.</p>	

SPECIFICATIONS

Input Signal	Pulse: 1-2 msec. wide; 4 volts p-p.
Thrust	3 lbs. at rotor.
Travel time	0.6 second.
Rotary Output Travel	90 degrees rotation.
Temperature Range	0 degrees to +160 degrees F.
Power Requirement	4.8 V CT battery. Idle Current: 15 mA maximum. Stall Current: 450 mA nominal. No Load Current: 80 mA.
Mechanical Output	1 large rotary arm. 1 small rotary arm. 1 offset rotary arm. 1 rotary wheel.
Position Accuracy	1.0%
Dimensions	1-17/32" high 23/32" wide x 1-7/8" long (length includes mounting ears. Height includes the outputs).
Net Weight	1.25 oz.



The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

The width of the 4-volt pulses from the receiver controls the position of the servo outputs. Widening the pulses drives the servo gear-train in one direction, and narrowing the pulses drives the servo gear-train in the other direction. The pulse widths are variable from one to two milliseconds, and are controlled by a transmitter stick control. Therefore, moving a transmitter stick changes the pulse width, which in turn causes the servo gear-train to move.

Refer to the Schematic Diagram (fold-out from Page 39) while you read this "Circuit Description."

INPUT AND TIMING CIRCUITS

A positive input pulse is coupled from the receiver, through the servo connector, to pin 2 of the IC (integrated circuit), and through capacitor C4 to pin 1 of the IC. The pulse causes the IC to generate a negative reference pulse. The width of

this reference pulse is controlled by feedback control R7, resistor R1, and capacitor C3.

The negative reference pulse is compared with the incoming positive pulse. If the incoming pulse is narrower than the reference pulse, then the difference between pulses is a small negative pulse that is inverted, shaped, and used to drive transistor Q2. However, if the incoming pulse is wider than the reference pulse, then the difference between pulses is a small positive pulse that is inverted, shaped, and used to drive transistor Q1.

Transistor Q1 drives the motor in one direction and transistor Q2 drives the motor in the other direction. The motor then turns the feedback control until the negative reference pulse is the same width as the positive incoming pulse. The pulses then cancel out and the motor stops. Resistor R5 couples the voltage from control R7 to pin 6 of the IC.

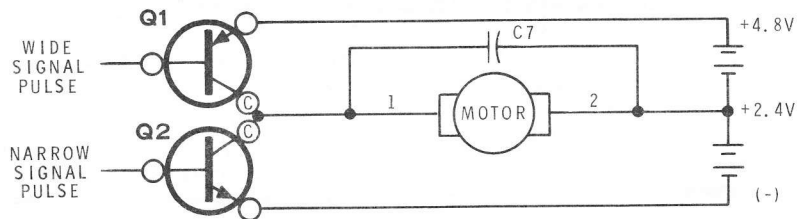


Figure 7

DRIVE CIRCUITS

The number 2 pole of the reversible motor is connected to the center tap of the battery as shown in the simplified schematic of Figure 7. The motor runs in one direction when the number 1 pole is connected to the positive end of the battery (through transistor Q1) and reverses direction when this pole is connected to the negative (ground) end of the battery (through transistor Q2). Capacitors C5 and C6 round the sharp switching pulse at the bases of transistors Q1 and Q2 and

capacitor C7 filters out motor brush noise. Resistors R2 and R3 provide bias for the IC and along with capacitors C1 and C2 modify the pulse shape to control the drive of transistors Q1 and Q2. Diodes D1, D2, D3, and resistor R4 limit the amount of drive to the transistors by limiting the voltage that capacitors C1 and C2 can charge to. This prevents excessive drive of the transistors under large error conditions. Resistor R6 is a damping resistor which prevents the Servo from overshooting.




CIRCUIT BOARD X-RAY VIEWS

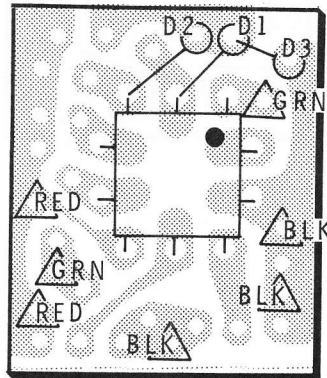
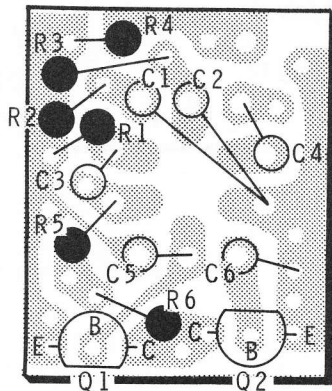
NOTE: To identify a part shown in one of these Views, so you can order a replacement, proceed as follows:




1. Note the identification number of the part (R-number, C-number, etc.).

2. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part (for example: 10 k Ω , .47 μ F, or MPS6560) will also appear near the part.
3. Look up this Description in the Parts List.

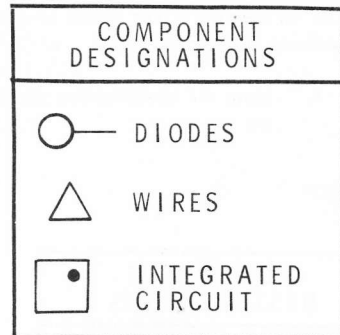
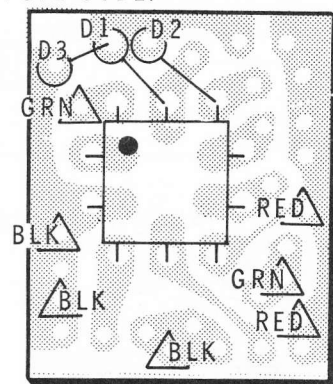
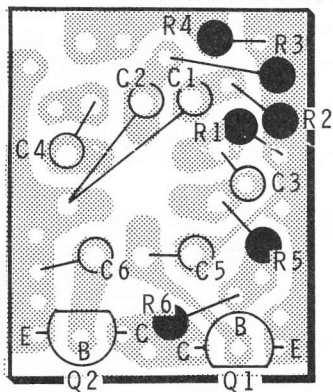
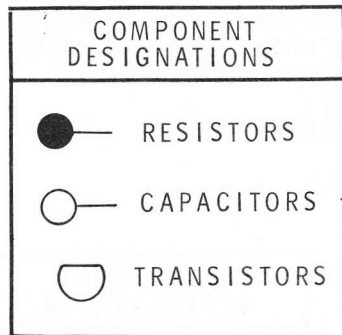
(SHOWN FROM COMPONENT SIDE)

COMPONENT DESIGNATIONS	
	RESISTORS
	CAPACITORS
	TRANSISTORS



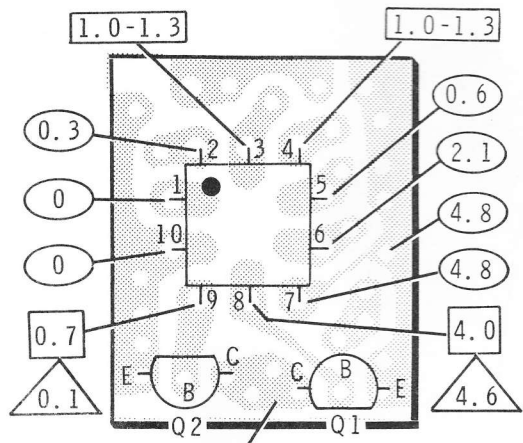
COMPONENT DESIGNATIONS	
	DIODES
	WIRES
	INTEGRATED CIRCUIT

(SHOWN FROM FOIL SIDE)


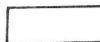




VOLTAGE CHART






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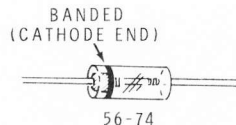
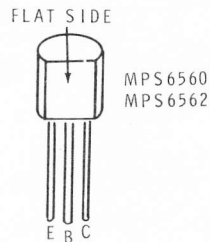
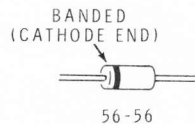


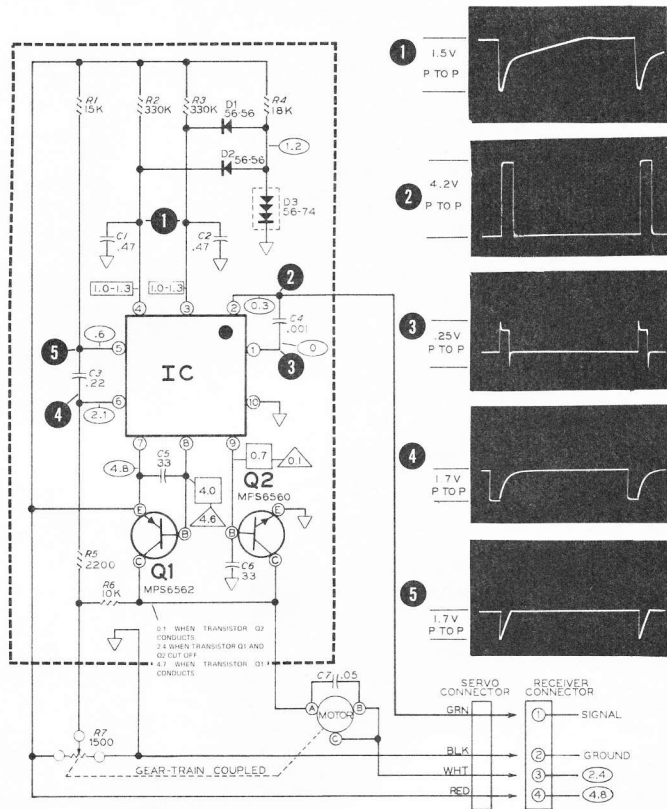
- 0.1 WHEN TRANSISTOR Q2 CONDUCTS.
- 2.4 WHEN TRANSISTOR Q1 AND Q2 CUT OFF.
- 4.7 WHEN TRANSISTOR Q1 CONDUCTS.

LEGEND	
	NORMAL VOLTAGE
	THIS SYMBOL INDICATES THE NORMAL OPERATING VOLTAGE RANGE.
	TRANSISTOR ON VOLTAGE
	TRANSISTOR OFF VOLTAGE

NOTES:

1. ALL RESISTORS ARE 1/4 WATT. RESISTOR VALUES ARE IN OHMS (K=1000).
2. ALL CAPACITOR VALUES ARE IN μF .
3.  THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT.
4.  THIS SYMBOL INDICATES THE NORMAL OPERATING VOLTAGE RANGE.
5.  THIS SYMBOL INDICATES ON VOLTAGE.
6.  THIS SYMBOL INDICATES OFF VOLTAGE.
7.  THIS SYMBOL INDICATES A WAVEFORM DISPLAY AT THE POINT INDICATED, AS SHOWN NEXT TO THE SCHEMATIC.
8. VOLTAGE ON PIN 2 OF THE IC IS VARIABLE FROM 0.2 TO 0.4, DEPENDING ON THE INPUT PULSE. VOLTAGE SHOWN IS WITH THE SERVO IN THE CENTER OF TRAVEL.
9. VOLTAGE ON PIN 6 OF THE IC IS VARIABLE FROM 1.5 TO 2.7, DEPENDING ON THE INPUT PULSE. VOLTAGE SHOWN IS WITH THE SERVO IN THE CENTER OF TRAVEL.
10. ALL VOLTAGES ARE MEASURED WITH A HIGH IMPEDANCE VOLTMETER FROM THE POINT INDICATED TO COMMON GROUND. VOLTAGES MAY VARY $\pm 20\%$.
11. REFER TO THE SERVO PHOTOGRAPH AND CIRCUIT BOARD X-RAY VIEW FOR THE PHYSICAL LOCATION OF PARTS.





**SCHEMATIC OF THE
 HEATHKIT®
 SUBMINIATURE DIGITAL PROPORTIONAL SERVO
 MODEL GDA-19-42**