3720681-502
CONTROL LEVEL MODULE

22

3720681-503
DC CONTROL MODULE

DESCRIPTION

GENERAL

The DC Control Module and Control Level Module are used to control regulator transistors that control the DC power input to the transmitter RF Power Amplifier. These transistors are mounted on the Power Amplifier casting to provide heat dissipation. The DC Control Module contains DC Control, DC Switching, and VSWR Amplifier stages. The Control Level Module contains diodes and potentiometers to adjust the feedback loops.

DC SWITCH Q1/Q2

The DC Switch stage, consisting of transistors Q1 and Q2, functions to turn the DC Control Module circuits on and off with the transmitter keying signal. When the transmitter is keyed, +13.6 volts is applied to pin 6, biasing Q1 into conduction. When Q1 conducts, the voltage at the junction of R3/R4 becomes less-positive, biasing Q2 into conduction. When Q2 conducts, it connects +13.6 volts from pin 7 to the Current Regulator (Q3), VSWR Amplifiers (Q8/Q9/Q10), and to pin 10. The keyed output at pin 10 is used to supply the switching bias for the antenna switch.

VSWR AMPLIFIERS – Q8/Q9/Q10

The VSWR Amplifiers amplify the difference between the forward and reverse power signals developed on the VSWR sensor, and produce an output voltage that is proportional to the standing wave ratio. This voltage is used as a feedback signal to reduce the power to the low level stages of the transmitter amplifier string.

The forward power signal is applied through R20 to the base of Q9, and sets its conduction level. The reverse power signal is applied through R19 to the base of Q8, and sets its conduction level. The conduction levels of Q8 and Q9, when compared with the reference voltage produced by zener diode CR5, set the conduction level of Q10, and consequently, the output voltage.

Q8 and Q9 share a common emitter resistor, R29. If the reverse power signal increases (becomes more positive) with respect to the forward power signal, the conduction level of Q8 increases, producing a more positive voltage at the junction of R28/R29. This increased positive voltage decreases the conduction of Q9, drawing less current through R26, and allowing the voltage on the base of Q10 to increase. As the base of Q10 becomes more positive, Q10 conducts more heavily, producing a more positive voltage at pin 4.

If the forward power signal increases with respect to the reverse power signal, the conduction of Q9 increases. Increased conduction by Q9 draws more current through R26, decreasing the voltage on the base of Q10. As the base of Q10 becomes less positive, Q10 conducts less heavily, producing a less-positive voltage at pin 4.

DC CONTROL STAGES – Q3/Q4/Q5/Q6/Q7

DC Control Amplifier Q7 supplies the control level to the Driver and Regulator transistors that control the voltage to the Power Amplifier stage. The base bias for Q7 is supplied by Current Regulator Q3, which provides a constant-current output when the transmitter is keyed. This constant current flowing through R16, produces the base voltage. Two feedback circuits are included to reduce the power to the Power Amplifier stage: the Undervoltage Gates (Q4/Q5), and the Error Amplifier (Q6).

The Undervoltage gates sense the voltage at the power amplifier input. If the voltage drops too low, Q4 will be biased into conduction. When Q4 conducts, base voltage is developed for Q5, turning it on. When Q5 conducts, it shunts all of the current from Q3 to ground, removing the bias from Q7 base, turning it off. This removes all power from the power amplifier stage.

The Error Amplifier stage reduces the bias on the base of Q7 when the voltage to the power amplifier increases beyond the nominal value, when the temperature of the PA transistors increases beyond nominal, or when the VSWR increases beyond the adjusted limit. The network R13/R14/R15 is a voltage divider on the PA input voltage, with R14 adjusting the base bias of Q6 to the threshold of conduction under normal operating conditions. The reference voltage for the amplifier is developed by CR3 (CR4 subtracts this reference for base bias on Q7). An increase in temperature, SWR, or PA voltage will drive Q6 into conduction in proportion to the error signal. Q6 then shunts some of the current from Q3 to ground, reducing the bias on Q7 base, and, consequently, reduces the power input to the power amplifier stage. The summing resistors R32 and R33 on the Control Level Module combine the SWR and temperature feedback signals on the base of Q6.

3720681-502
CONTROL LEVEL MODULE

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3720681-503
DC CONTROL MODULE

REPLACEMENT PARTS

Symbol	Stock No.	Drawing No.	Description
		3720681-503	DC CONTROL MODULE P/L 3720681-503 REV 16
22C1	255900	3457333-451	Tantalum, 1.5MF 10% 10V
22C2	231679	3457333-156	Tantalum, 1.5MF 20% 20V
22C3	249692	3457333-093	Tantalum, 3.3MF 20% 15V
22C4	225842	3457333-095	Tantalum, 4.7MF 20% 15V
22C5	233878	3463453-118	Ceramic 0.02 MFD, +80-20% 25V
22C8	232752	3460490-015	Disc, 0.02MFD, +80-20% 25V
22C9	232752	3460490-015	Disc, 0.02MFD, +80-20% 25V
22C10	232752	3460490-015	Disc, 0.02MFD, +80-20% 25V
22C11	232752	3460490-015	Disc, 0.02MFD, +80-20% 25V
22CR1	249695	3731199-006	Diode-Zener, 3.9V
22CR2	242522	3464611-001	Diode, Silicon - Type 1N914
22CR3	249694	3731199-006	Diode-Zener, 3.9V
22CR4	421009	3722331-002	Diode-Zener, 3.9V 5%
22CR5	246976	3457639-005	Diode-Zener, 11.0V
22CR8	421004	3720731-006	Diode-Zener, 6.0V 5%
22Q1	242758	3468182-001	Transistor-Silicon, NPN
22Q2	242760	3468183-001	Transistor-Silicon, PNP
22Q3	242760	3468183-001	Transistor-Silicon, PNP
22Q4	242760	3468183-001	Transistor-Silicon, PNP
22Q5	242758	3468182-001	Transistor-Silicon, NPN
22Q6	242758	3468182-001	Transistor-Silicon, NPN
22Q7	230254	3463099-001	Transistor-Silicon, NPN
22Q8	242758	3468182-001	Transistor-Silicon, NPN
22Q9	242758	3468182-001	Transistor-Silicon, NPN
22Q10	242758	3468182-001	Transistor-Silicon, NPN
22R1	218499	99206-074	10,000 Ohms 10% 1/4W
22R2	108871	99206-082	47,000 Ohms 10% 1/4W
22R3	108861	99206-050	100 Ohms 10% 1/4W
22R4	108865	99206-062	1000 Ohms 10% 1/4W
22R5	219458	99206-056	330 Ohms 10% 1/4W
22R6	285442	99206-060	680 Ohms 10% 1/4W
22R7	285405	99206-069	3900 Ohms 10% 1/4W
22R8	218758	99206-054	220 Ohms 10% 1/4W
22R9	108866	99206-066	2200 Ohms 10% 1/4W
22R10	108865	99206-062	1000 Ohms 10% 1/4W
22R11	218499	99206-074	10,000 Ohms 10% 1/4W
22R12	285442	99206-060	680 Ohms 10% 1/4W
22R13	219459	99206-064	1500 Ohms 10% 1/4W
12R14	236640	3463187-008	Variable, 1000 Ohms
22R15	300690	99206-061	820 Ohms 10% 1/4W
22R16	300690	99206-061	820 Ohms 10% 1/4W
22R17	502033	82283-044	33 Ohms 10% 1/2W
22R18	502210	82283-062	1000 Ohms 10% 1/2W
22R19	249929	3463187-009	Variable, 10,000 Ohms
22R20	249930	3463187-010	Variable, 100,000 Ohms
22R21	108869	99206-076	15,000 Ohms 10% 1/4W
22R22	502210	99206-062	1000 Ohms 10% 1/4W
22R23	300690	99206-061	820 Ohms 10% 1/4W
22R24	108870	99206-077	18,000 Ohms 10% 1/4W
22R25	218758	99206-054	220 Ohms 10% 1/4W
22R26	219459	99206-064	1500 Ohms 10% 1/4W
22R27	300739	99206-070	4700 Ohms 10% 1/4W
22R28	108865	99206-062	1000 Ohms 10% 1/4W
22R29	108864	99206-058	470 Ohms 10% 1/4W
22R30	108870	99206-077	18,000 Ohms 10% 1/4W

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CONTROL LEVEL MODULE

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3720681-503
DC CONTROL MODULE

Symbol	Stock No.	Drawing No.	Description
22	228124	3450797-003	Contact Pin, Bead Chain (Package of 5)
20	228192	3450825-001	Socket .093 Diameter (Package of 5)
17	248228	8985442-001	Washer, Insulator, for Q7
16		3467007-004	Heat Sink
			PA REGULATOR COMPONENTS - MOUNTED EXTERNAL TO THE DC CONTROL MODULE NOT PART OF P/L 3720681-503
	249711	3731353-001	Regulator Transistor (PNP)
	232628	3463100-001	Driver Transistor (NPN)
	240143	3463424-001	Regulator Transistor Socket
	240243	3464535-001	Driver Transistor Socket
	522012	99126-039	120 Ohms, 10%, 2W
	256444	3465422-036	4 Ohms, 5%, 20W
	249693	3450123-072	1 Ohm, 10%, 5W

Symbol	Stock No.	Drawing No.	Description
			CONTROL LEVEL MODULE P/L 3720681-502 REV 18
22C6	232752	3460490-015	Disc, 0.02MFD
22C7	232752	3460490-015	Disc, 0.02MFD
22CR6	242522	3464611-001	Diode, Silicon
22CR7	242522	3464611-001	Diode, Silicon
22R32	249929	3463187-009	Variable, 10,000 Ohms
22R33	249929	3463187-009	Variable, 10,000 Ohms
	228124	3450797-003	Contact Pin, Bead Chain (Package of 5)

EMERGENCY SUBSTITUTES-SOLID STATE DEVICES

In the event of a semiconductor failure, the exact replacement found in the replacement parts list should be used. In an emergency, to minimize equipment downtime, the following common semiconductor types may be temporarily used. However, use of these substitutes may result in degraded system performance.

Component Designation	Emergency Substitute
22CR1	Zener, 3.9V
22CR2	1N914
22CR3	Zener, 3.9V
22CR4	Zener, 3.9V 5%
22CR5	1N5241 Zener, 11.0V
22CR6	1N914
22CR7	1N914
22CR8	1N5233B Zener, 6.0V
22Q1	2N4123

Component Designation	Emergency Substitute
22Q2	2N4125
22Q3	2N4125
22Q4	2N4125
22Q5	2N4123
22Q6	2N4123
22Q7	2N3053
22Q8	2N4123
22Q9	2N4123
22Q10	2N4123

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CONTROL LEVEL MODULE

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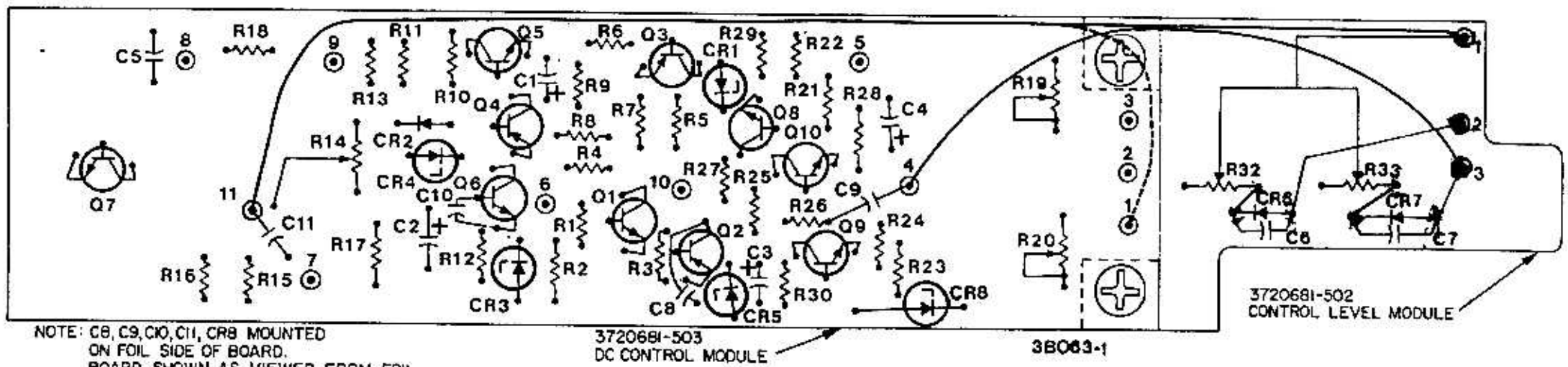
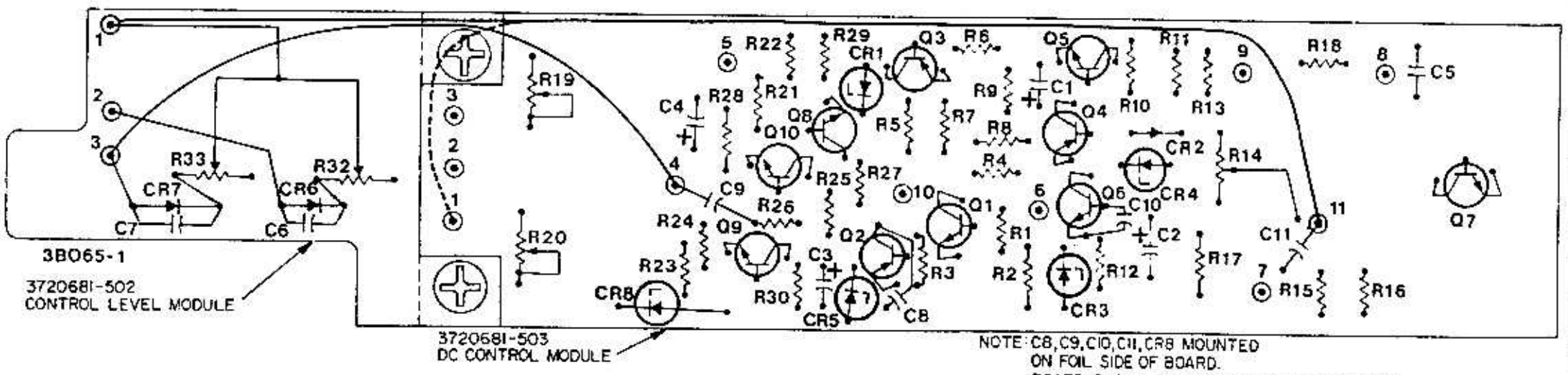
DC CONTROL MODULE





Pathfinder Diagram

3720681-502
CONTROL LEVEL MODULE

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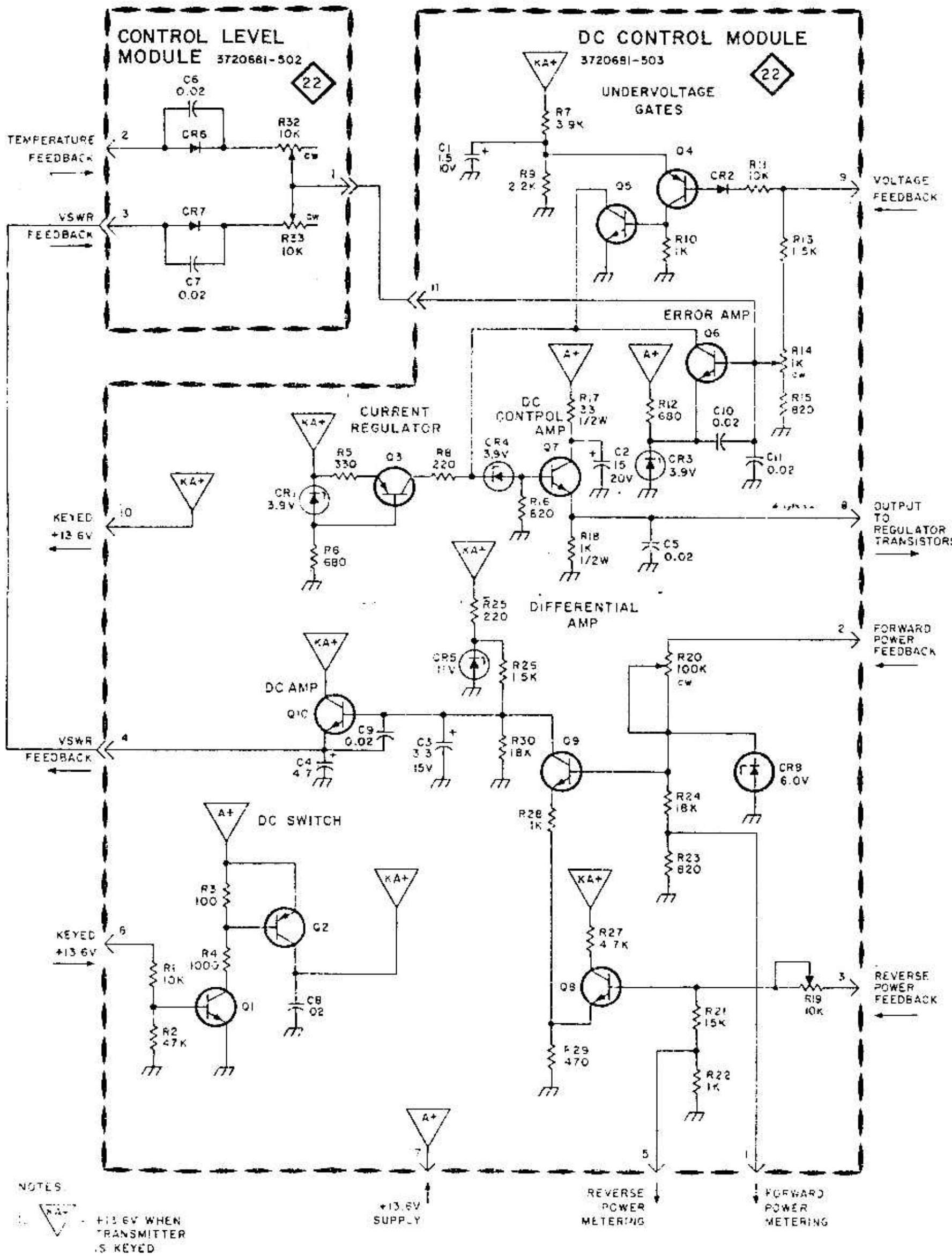
3720681-503
DC CONTROL MODULE



NOTES:

1. KA+ - +13.6V WHEN TRANSMITTER IS KEYED

2 ALL RESISTOR VALUES ARE IN OHMS, 10%, .4 WATT, EXCEPT AS NOTED.

3 ALL CAPACITORS VALUES ARE IN MICROFARADS, EXCEPT AS NOTED

28025 1

DESCRIPTION

GENERAL

The DC Control Module is used to control regulator transistors that control the DC power input to the transmitter power amplifier. These transistors are mounted on the Power Amplifier casting to provide heat dissipation. The module contains DC Control, DC Switching, and VSWR Amplifier stages.

DC SWITCH – Q1/Q2

The DC Switch stage, consisting of transistors Q1 and Q2, functions to turn the DC Control Module circuits on and off with the transmitter keying signal. When the transmitter is keyed, +13.6 volts are applied to pin 6, biasing Q1 into conduction. When Q1 conducts, the voltage at the junction of R3/R4 becomes less positive, biasing Q2 into conduction. When Q2 conducts, it connects +13.6 volts from pin 7 to the Current Regulator (Q3), VSWR Amplifiers (Q8/Q9/Q10), and to pin 10. The keyed output at pin 10 is used to power external circuitry, such as the temperature feedback network, or to supply the switching bias for the antenna switch.

VSWR AMPLIFIERS – Q8/Q9/Q10

The VSWR Amplifiers amplify the difference between the forward and reverse power signals developed by the VSWR sensor, and produce an output voltage that is proportional to the standing wave ratio. This voltage is used as a feedback signal to control the transmitter RF power output.

The forward power signal is applied through R20 to the base of Q9, and sets its conduction level. The reverse power signal is applied to the base of Q8, and sets its conduction level. The conduction levels of Q8 and Q9, when compared to the reference voltage produced by zener diode CR5 set the conduction level of Q10, and, consequently, the output voltage.

Q8 and Q9 share a common emitter resistor, R29. If the reverse power signal increases (becomes more positive) with respect to the forward signal, the conduction level of Q8 increases, producing a more positive voltage at the junction of R28/R29. This increased positive voltage decreases the conduction of Q9, drawing less current through R26, and allowing the voltage on the base of Q10 to increase. As the base of Q10 becomes more positive, Q10 conducts more heavily, producing a more positive output voltage at pin 4.

If the forward power signal increases with respect to the reverse power signal, the conduction level of Q9 increases. Increased conduction by Q9 draws more current through R26, decreasing the voltage on the base of Q10. As the base of Q19 becomes less positive, Q10 conducts less heavily, producing a less positive output voltage at pin 4.

DC CONTROL STAGES – Q3/Q4/Q5/Q6/Q7

DC Control Amplifier Q7 supplies the control level to the Driver and Regulator transistors that control the voltage to the RF Power Amplifier stage of the transmitter. The base bias for Q7 is supplied by Current Regulator Q3, which produces a constant-current output when the transmitter is keyed. This constant current flowing through R16 produces the base bias. Two feedback circuits are included to reduce the power to the Power Amplifier: the Undervoltage Gates (Q4/Q5) and the Error Amplifier (Q6).

The Undervoltage Gates sense the voltage at the power amplifier input. If the voltage drops too low, Q4 will be biased into conduction. When Q4 conducts, base voltage is developed for Q5, turning it on. When Q5 conducts, it shunts all of the current from Q3 to ground, removing the bias from the base of Q7, and causing it to be cut off. This, in turn, causes the external regulator transistors to turn off the power to the transmitter RF power amplifier.

The Error Amplifier circuit reduces the bias on the base of Q7 when the voltage to the transmitter RF power amplifier increases beyond nominal, when the temperature of the power amplifier transistors increases beyond a safe limit, or when the SWR increases beyond the adjusted limit. The network R13/R14/R15 is a voltage divider on the power amplifier input voltage, with R14 adjusting the base bias of Q6 to the threshold of conduction under normal operating conditions. The reference voltage for the amplifier is developed by CR3 (CR4 subtracts this reference for base bias on Q7). An increase in temperature, SWR, or power amplifier input voltage will drive Q6 into conduction in proportion to the error signal. Q6 then shunts some of the current from Q3 to ground, reducing the bias on Q7 base, and, consequently, reducing the power input to the transmitter power amplifier.

PRODUCTION VARIATIONS

The production level of the module is indicated by a legend (example: CODE B) stamped on the module near the identifying drawing number. The following table lists the differences between the various production levels. To determine the difference between a given production level and the level shown on the pathfinder, schematic, and parts list, note the differences tabulated for the desired level and all subsequent levels.

DC CONTROL MODULE
Current Version: 3720681-504 CODE F

Code Level Difference	Instruction Book Reference	Changes for Code Level Differences			
D-E	Component Values	Symbol	Stock No.	Dwg. No.	Description
		22R3	108861	99206-050	100 OHMS 10% 1/4W
E-F	Component Values	Symbol	Stock No.	Dwg. No.	Description
		22R16	300690	99206-061	820 OHMS 10% 1/4W

EMERGENCY SUBSTITUTES-SOLID STATE DEVICES

In the event of a semiconductor failure the exact replacement found in the replacement parts list should be used. In an emergency, to minimize equipment downtime, the following common semiconductor types may be temporarily used. However, use of these substitutes may result in degraded system performance.

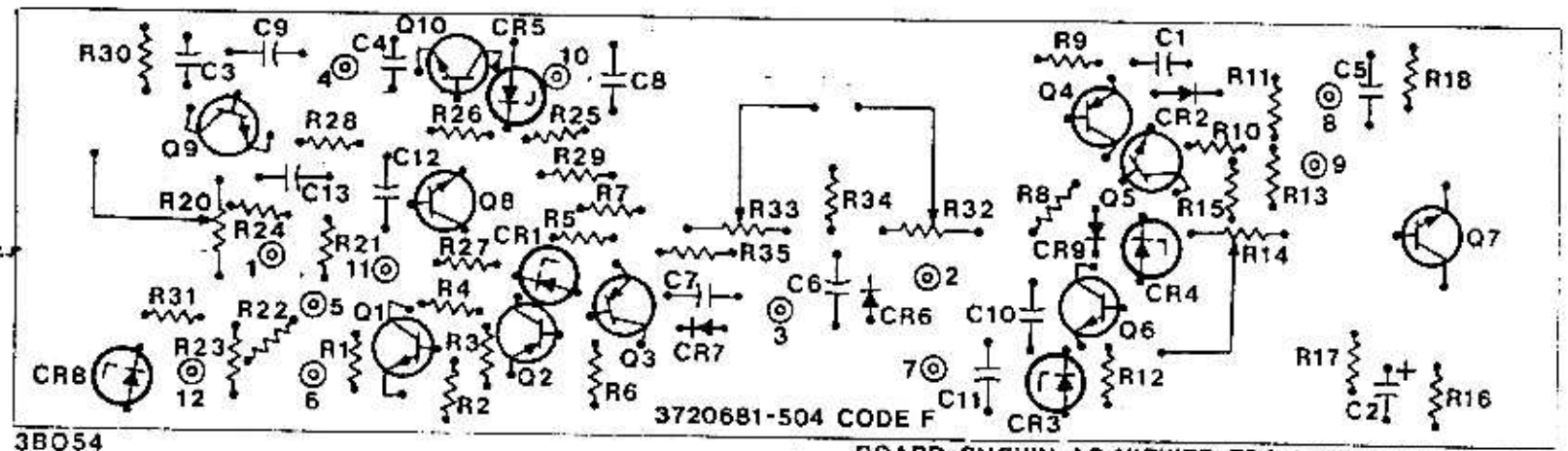
Component Designation	Emergency Substitute
22CR1	Zener, 3.9V
22CR2	1N914
22CR3	Zener, 3.3V
22CR4	Zener, 3.9V 5%
22CR5	1N5241 Zener, 11.0V
22CR6	1N914
22CR7	1N914
22CR8	1N5233 B Zener, 6.0V
22CR9	1N914

Component Designation	Emergency Substitute
22Q1	2N4123
22Q2	2N4125
22Q3	2N4125
22Q4	2N4125
22Q5	2N4123
22Q6	2N4123
22Q7	2N3053
22Q8	2N4123
22Q9	2N4123
22Q10	2N4123

REPLACEMENT PARTS

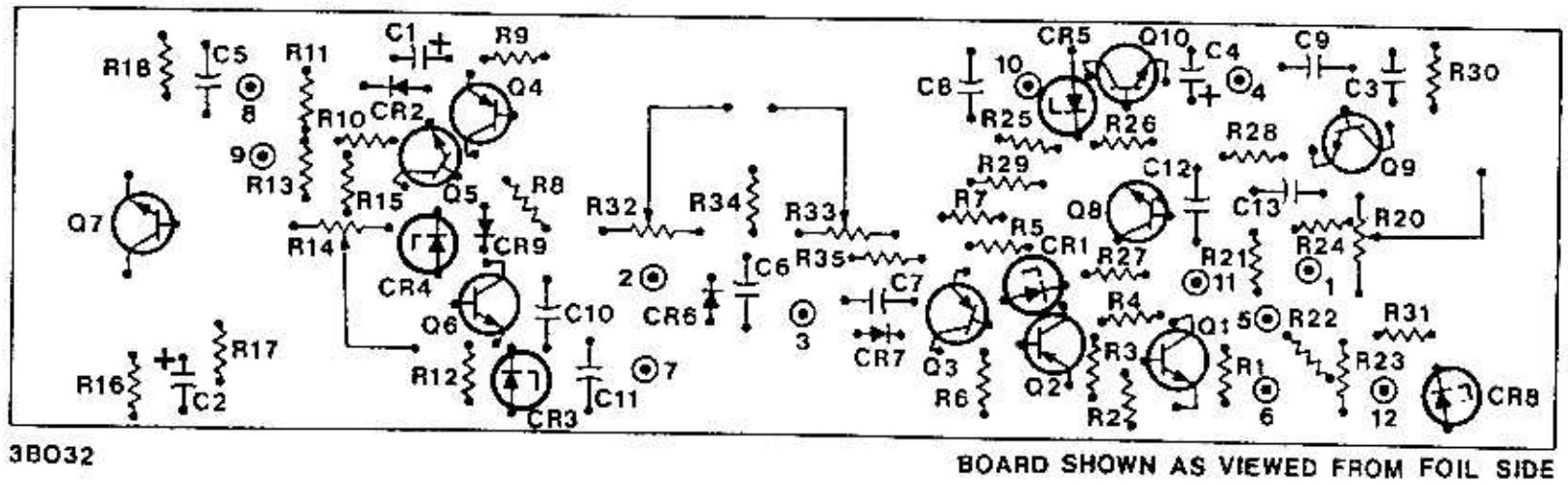
Symbol	Stock No.	Drawing No.	Description
	421017	3720681-504	DC CONTROL MODULE-CODE F P/L 3720681-504 Rev 18
22C1	255900	3457334-451	Tantalum, 1.5UF 10% 10V
22C2	231679	3457334-156	Tantalum, 1.5UF 20% 20V
22C3	249692	3457334-093	Tantalum, 3.3UF 20% 15V
22C4	421435	3457334-095	Tantalum, 4.7UF 20% 15V
22C5	233878	3463453-118	Ceramic, 0.02MFD, +80-20%, 25V
22C6 Thru 22C13	232752	3460490-015	Disc, 0.02MFD +80-20% 25V
22CR1	249694	3731199-006	Diode, Zener 3.9V
22CR2	242522	3464611-001	Diode, Silicon
22CR3	421481	3731199-104	Diode, Zener 3.3V 5%
22CR4	421009	3722331-102	Diode, Zener 3.9V 5%
22CR5	246976	3457639-005	Diode, Zener 11.0V
22CR6	242522	3464611-001	Diode, Silicon
22CR7	242522	3464611-001	Diode, Silicon
22CR8	421004	3720731-006	Diode, Zener 6.0V 5%
22CR9	242522	3464611-001	Diode, Silicon
22Q1	242758	3468182-001	Transistor, Silicon
22Q2 Thru 22Q4	242760	3468183-001	Transistor, Silicon
22Q5	242758	3468182-001	Transistor, Silicon
22Q6	242758	3468182-001	Transistor, Silicon
22Q7	230254	3463099-001	Transistor, Silicon
22Q8 Thru 22Q10	242758	3468182-001	Transistor, Silicon
22R1	218499	99206-074	10K Ohms 10% 1/4W
22R2	108871	99206-082	47K Ohms 10% 1/4W
22R3	227741	99206-059	560Ohms 10% 1/4W
22R4	108865	99206-062	1000 Ohms 10% 1/4W
22R5	219458	99206-056	330 Ohms 10% 1/4W
22R6	285442	99206-060	680 Ohms 10% 1/4W
22R7	285405	99206-069	3900 Ohms 10% 1/4W
22R8	218758	99206-054	220 Ohms 10% 1/4W
22R9	108866	99206-066	2200 Ohms 10% 1/4W
22R10	108865	99206-062	1000 Ohms 10% 1/4W
22R11	218499	99206-074	10K Ohms 10% 1/4W
22R12	227741	99206-059	560 Ohms 10% 1/4W
22R13	219459	99206-064	1500 Ohms 10% 1/4W
22R14	236640	3463187-008	Variable, 1000 Ohms
22R15	300690	99206-061	820 Ohms 10% 1/4W
22R16	227741	99206-059	560 Ohms 10% 1/4W
22R17	502033	82283-044	33 Ohms 10% 1/2W
22R18	502210	82283-062	1000 Ohms 10% 1/2W
22R20	249930	3463187-010	100K Ohms
22R21	108869	99206-076	15K Ohms 10% 1/4W
22R22	108865	99206-062	1000 Ohms 10% 1/4W
22R23	300690	99206-061	820 Ohms 10% 1/4W
22R24	108870	99206-077	18K Ohms 10% 1/4W
22R25	218758	99206-054	220 Ohms 10% 1/4W
22R26	219459	99206-064	1500 Ohms 10% 1/4W
22R27	300739	99206-070	4700 Ohms 10% 1/4W
22R28	108865	99206-062	1000 Ohms 10% 1/4W
22R29	108864	99206-058	470 Ohms 10% 1/4W

Symbol	Stock No.	Drawing No.	Description
22R30	108870	99206-077	18K OHMS 10% 1/4W
22R31	108861	99206-050	100 OHMS 10% 1/4W
22R32	249929	3463187-009	VARIABLE, 10K OHMS
22R33	249929	3463187-009	VARIABLE, 10K OHMS
22R34	108864	99206-058	470 OHMS 10% 1/4W
22R35	108864	99206-058	470 OHMS 10% 1/4W
	246228	8985442-001	WASHER, INSULATOR, FOR Q7
	228124	3450797-003	CONTACT PIN, (PACKAGE OF 5)
			PA REGULATOR COMPONENTS - MOUNTED EXTERNAL TO THE DC CONTROL MODULE - NOT PART OF P/L 3720681-504
	249711	3731353-001	REGULATOR TRANSISTOR (PNP)
	232628	3463100-001	DRIVER TRANSISTOR (NPN)
	240143	3463424-001	REGULATOR TRANSISTOR SOCKET
	240243	3464535-001	DRIVER TRANSISTOR SOCKET
	522012	99126-039	12 OHMS, 10% 2W
	256444	3465422-036	4 OHMS, 5% 20W
	249693	3450123-072	1 OHM, 10% 5W



3BO54

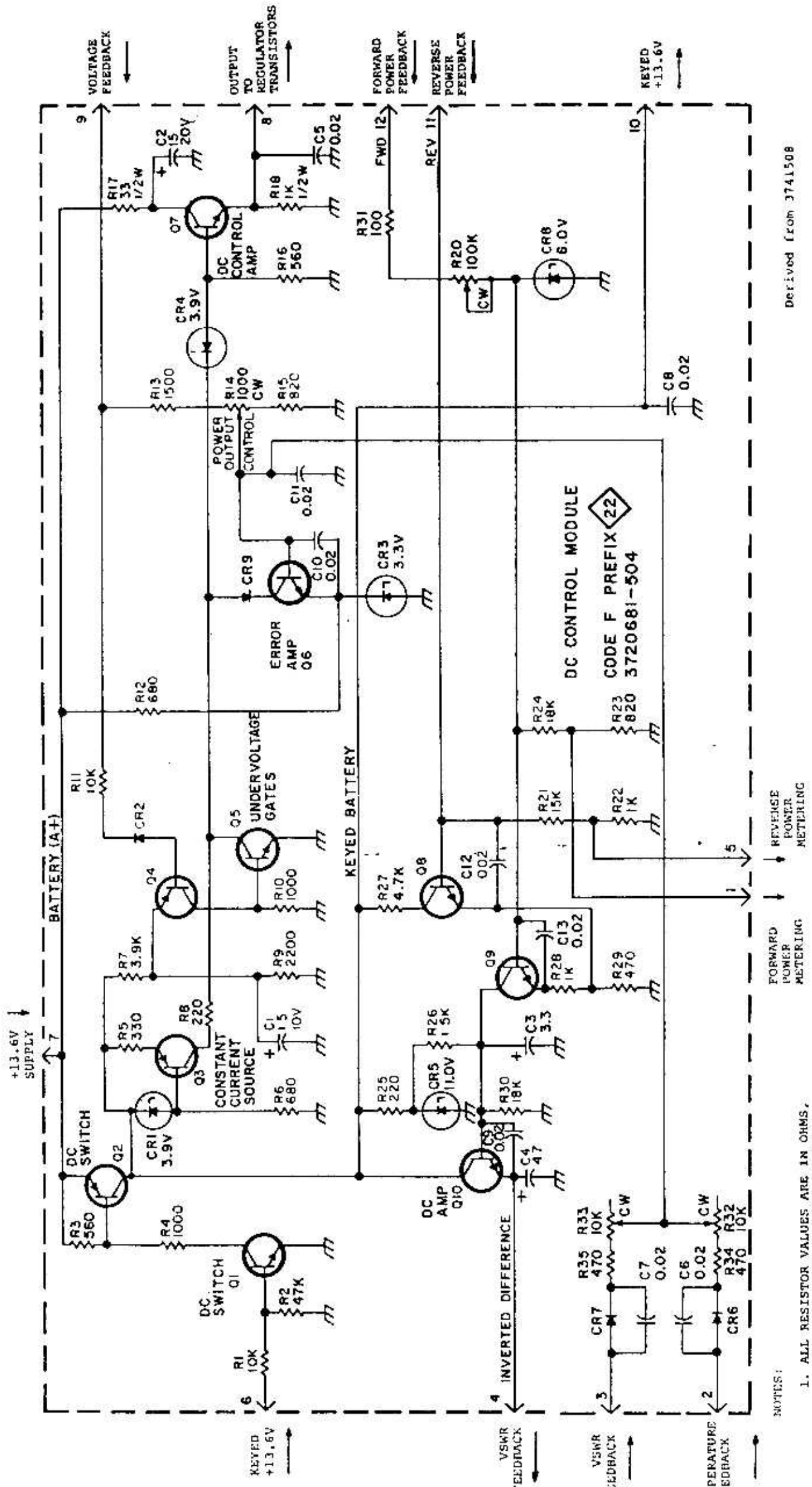
BOARD SHOWN AS VIEWED FROM COMPONENT SIDE



3BO32

BOARD SHOWN AS VIEWED FROM FOIL SIDE

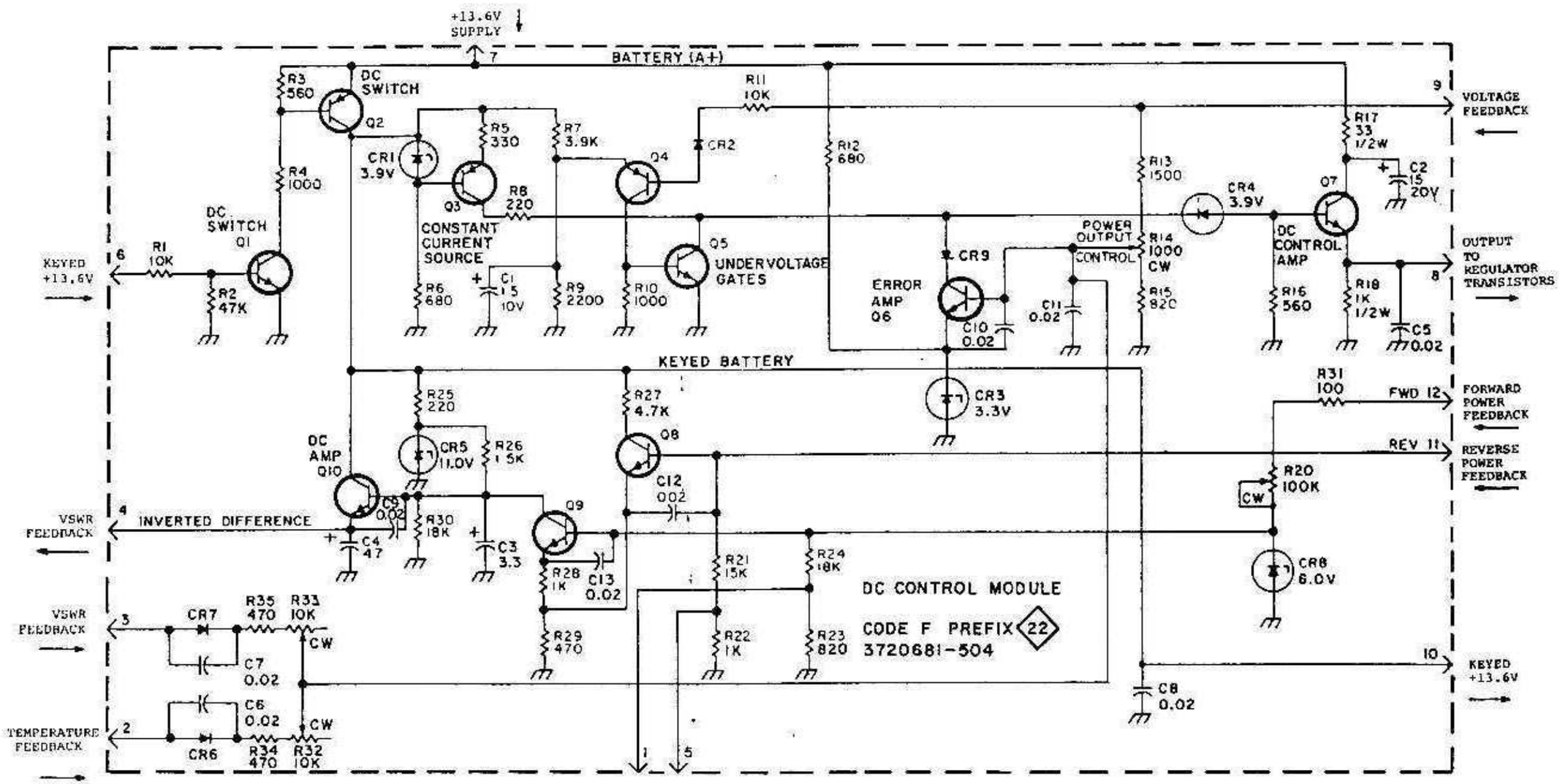
Pathfinder Diagrams



NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS, 10%, 1/4 WATT, EXCEPT AS NOTED.
2. ALL CAPACITORS VALUES ARE IN MICROFARADS, EXCEPT AS NOTED.

Schematic Diagram



NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS, 10%, 1/4 WATT, EXCEPT AS NOTED.
2. ALL CAPACITORS VALUES ARE IN MICROFARADS, EXCEPT AS NOTED.

Derived from 3741508