GATE MODULATOR BOARD

Schematic Diagram	657C350
Printed Circuit Assy.	658C605

FUNCTION

The gate modulator board is located in the power module drawer, where it serves the purpose of converting incoming gate control signals from the counter/driver board, into properly shaped and isolated gate drive signals for the thyristors of one complete inverter stage. Two such boards, each of plug-in construction, are located in the power module drawer; one for the control of each stage.

Each board contains two identical sections. The left-hand section controls the thyristors SCR 11 and SCR 12, associated with the left-hand side of the inverter stage. The right-hand section controls the thyristors SCR 21 and SCR 22, associated with the right-hand side of the inverter stage. Both sections operate in the same manner, goverened by their independent input control signals from the counter/driver board. The discussion of one section will suffice for both.

Each section of the gate modulator board has one-half for control of thyristor SCR 11, which is the ON-dominant upper thyristor; and one-half for thyristor SCR 12, which is the OFF-dominant thyristor. The signals for each half are complementary; that is, when one is ON the other must be OFF, and vice versa. This is true of the input gate control signals also, of course, since both thyristors can never be turned ON simultaneously without causing a misfire. (This is true except at the instant of thyristor commutation, when the firing of one thyristor extinguishes current flow in the other.)

Since the basic function of the gate modulator is to produce gate signals for the thyristors with isolation, noise security, and special shaping, a carrier signal is utilized for this purpose. Furthermore, the gate signal is built up of three parts: (1) the main "holding" signal, necessary to maintain the thyristor in conduction once fired; (2) a very fast-rising and high-level "initiating" signal, necessary to achieve the fast turn-on of the thyristor required for inverter service; and (3) a reverse-biasing signal to the gate during the OFF portion of the thyristor, to assure that any stray noise will not cause false firing. Refer to Figures 1 and 2 for the waveshapes to be produced.

OPERATION

For easiest understanding of gate modulator operation, consider only one half-section controlling one thyristor. Referring to schematic diagram 657C350, one half-section comprises that circuitry associated with the incoming gate control signal 2, gate transformer 1T, bias transformer 2T, diode-capacitor networks, gating thyristor SCR3, and the output to the gate G11-K11 of thyristor SCR11.

Both transformers 1T and 2T are connected to the carrier supply, which is a high-frequency, square-wave voltage, SWA and SWB. The gate transformer 1T is energized continuously, and its secondary voltage is rectified full wave to provide a source of gating voltage of approximately 15 volts DC. The source is blocked by the gating thyristor SCR3 until this thyristor is turned on, which action will be described later. Capacitor 1C is charged to 15 volts.

The bias transformer 2T not energized because of the blocking diodes 1D and 2D, unless there is a gate control signal 2 present. This signal provides a path from the center tap of 2T, 2R, and externally through the driver transistor of the counter/driver board, back to the neutral of the square-wave supply. When such a gate control signal is present, a secondary voltage appears, is rectified by 5D and 6D to produce an output which is also approximately 15 volts.

This bias supply produces negative bias to SCR11 during its OFF time, by means 5D-6D to K11-G11 shunted by 7D, through 5R back to the center tap of 2T. The negative bias on SCR11 is necessary to prevent "noise" from turning on SCR11 at the wrong time. Notice that gate control signal 2 produces the negative bias on SCR11 during the OFF period. Thus, GC2 and SCR11 are complementary.

A second and main function of the bias supply is to control the gating SCR3. When GC2 is present, the 15 volt bias is also present and 2C charges to approximately 30 volts because the gate and bias voltages are tied together at 5D and K11. The gate voltage is +15 with respect to K11, while the bias voltage is -15 with respect to K11. Under this condition, the cathode voltage of SCR3 is about -1 volt, clamped by 7D. The gate-to-cathode voltage of SCR3 is developed across 3R and 4R, with the gate voltage reverse biased by a small amount.

When GC2 signal turns OFF, the bias voltage disappears, rising from -15 toward zero. The gate of SCR3 rises accordingly, firing SCR3 and in turn gating the main SCR11. Capacitor 2C has been charged previously to 30 volts, thus the initial gate signal to SCR11 is very high giving the desired fast turn-on. After 2C discharges, the holding value of gate current is that produced by the gating voltage only.

When GC2 signal turns ON, the bias voltage reappears and 2C begins charging again. This charging current is diverted from SCR3 which then turns off. The original condition described is now restored, ready for the next cycle.

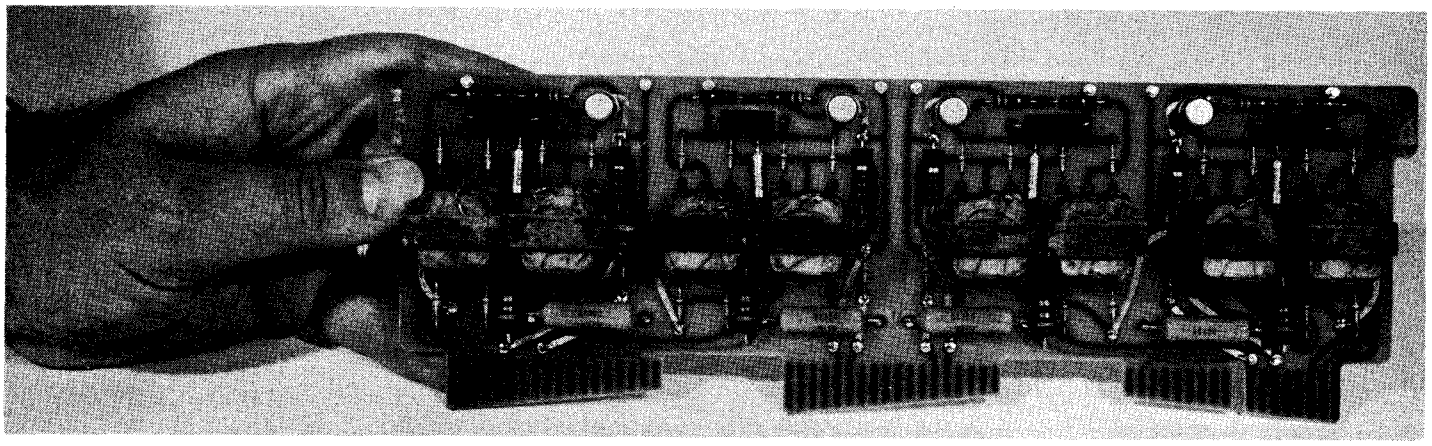
TESTING

Supply voltages to the gate modulator board are the carrier supply, which is the high-frequency (approximately 10 kc) square-wave SWA, SWB. This voltage is approximately 80 volts peak-to-peak. The input signal is that received from the output of the counter/driver board, which is a stepped wave of either +40 or +20 volts amplitude. The neutral of the square-wave carrier supply is connected to +20 volt supply also. The output of gate modulator board is the group of thyristor gate signals similar to Figure 1.

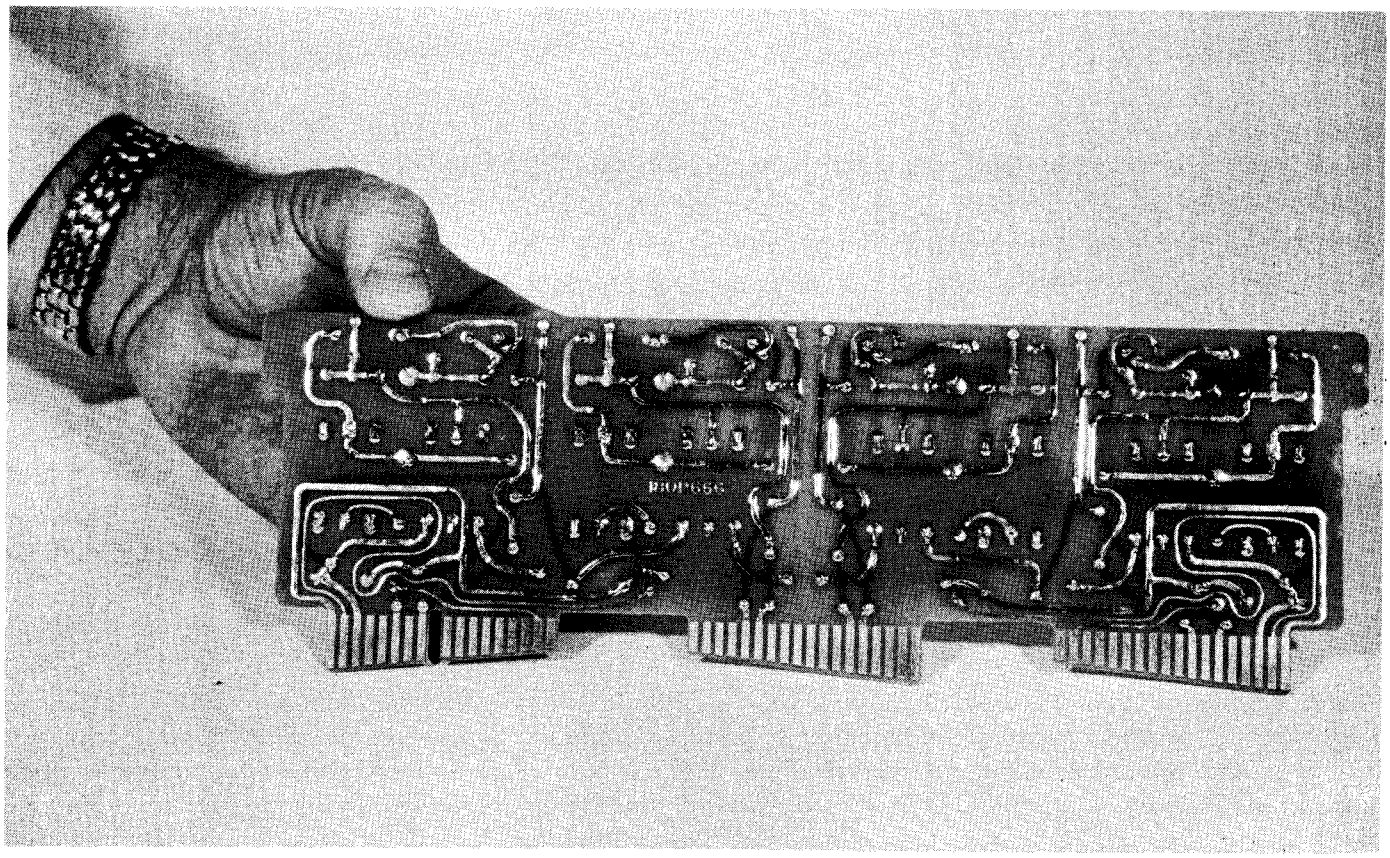
The gate modulator board has no adjustments, and therefore there is no setup test. A simple GO/NO GO checkout procedure is employed to verify the presence or absence of certain signals. Convenient test points are provided at each thyristor gate. Absence of a gate signal at a thyristor should be checked back toward the input signal to determine where loss occurs.

A useful indicator in determining thyristor condition is the forward gate drop. This voltage is easily measured with an oscilloscope, and a record should be kept for each thyristor, preferably by a sticker on the power module drawer. The gate drop will normally be between 2 and 5 volts, which values vary between thyristors. The important check, however, is to note any appreciable change in this gate drop value with time, since this will be an indication of any damage or degradation of the thyristor.

NOTE: When viewing gate signals with an oscilloscope, some difficulty may be experienced in scope synchronization. The use of the EXTERNAL SYNC signal taken from the appropriate counter/driver board test point, will permit easy measurement. Be sure such gate measurements are done with main power OFF, since scope noise during placement of the probe may cause thyristor misfire.



GATE MODULATOR BOARD
(Front View)



GATE MODULATOR BOARD
(Rear View)

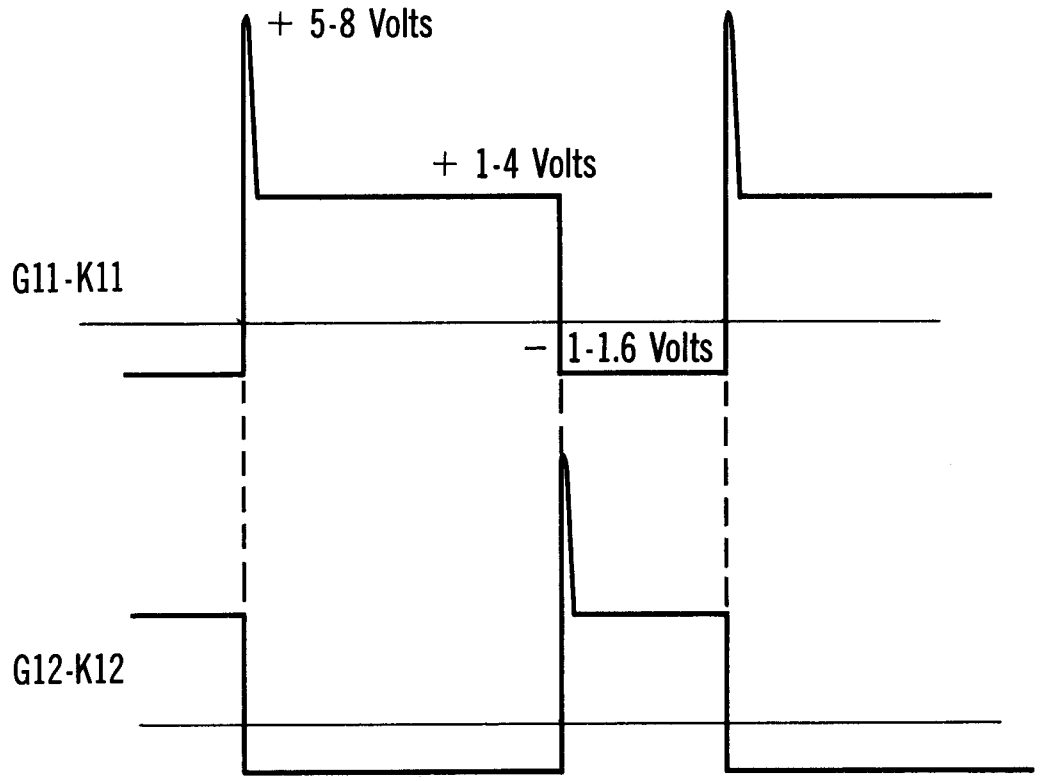


FIGURE 1 - TYPICAL THYRISTOR GATE SIGNALS AND VOLTAGES

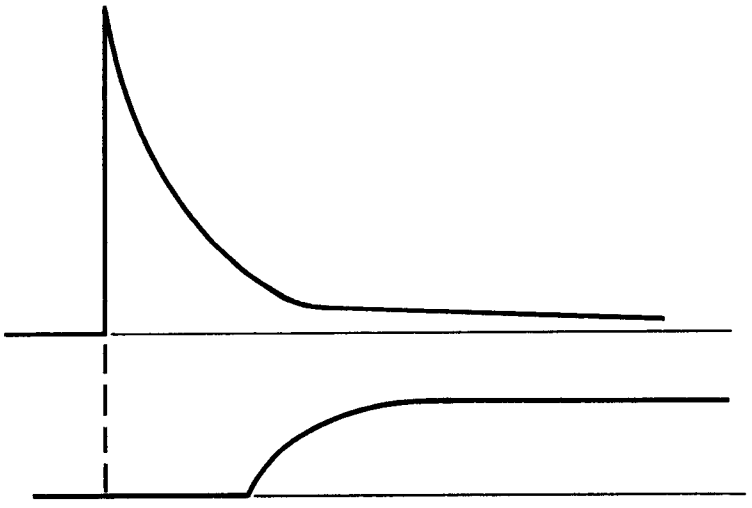
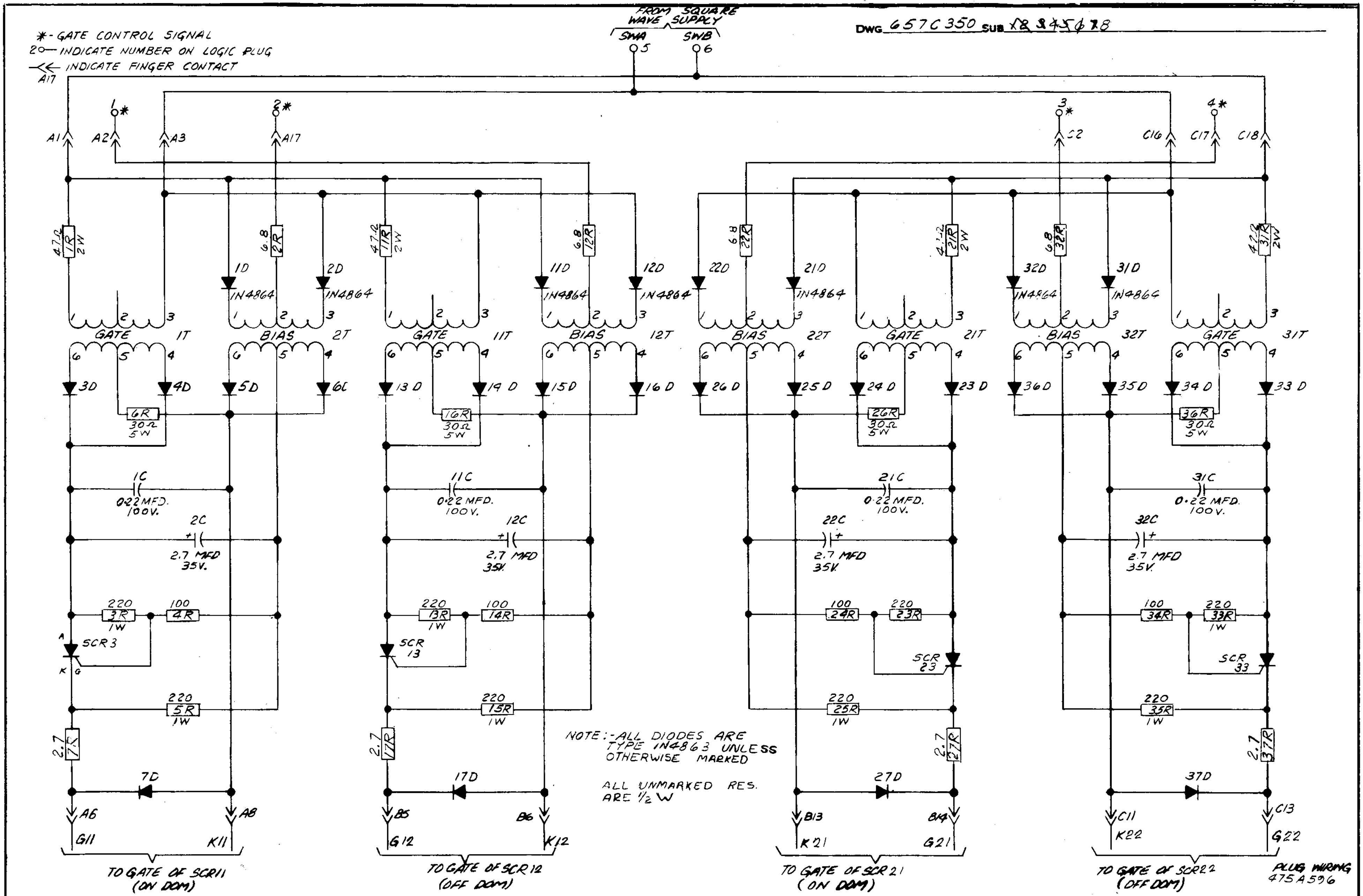


FIGURE 2 - EXPANDED TIME SCALE SHOWING LEADING EDGE OF FAST-RISE AND HOLDING COMPONENTS OF GATE SIGNAL



*- GATE CONTROL SIGNAL
2○— INDICATE NUMBER ON LOGIC PLUG
≺≺ INDICATE FINGER CONTACT A17
FROM SQUARE WAVE SUPPLY
SWA 5
SWB 6
DWG 657C350 SUB X8 345678
A1 A2 A3 A17 C2 C16 C17 C18
GATE 1T
BIAS 2T
GATE 11T
BIAS 12T
BIAS 22T
GATE 21T
BIAS 32T
GATE 31T
1C 0.22 MFD. 100V.
2C 2.7 MFD 35V.
11C 0.22 MFD. 100V.
12C 2.7 MFD 35V.
21C 0.22 MFD. 100V.
22C 2.7 MFD 35V.
31C 0.22 MFD. 100V.
32C 2.7 MFD 35V.
SCR 3
SCR 13
SCR 23
SCR 33
NOTE:- ALL DIODES ARE TYPE 1N4863 UNLESS OTHERWISE MARKED
ALL UNMARKED RES. ARE 1/2 W
A6 G11 A8 K11
B5 G12 B6 K12
B13 K21 B14 G21
C11 K22 C13 G22
TO GATE OF SCR11 (ON DOM)
TO GATE OF SCR12 (OFF DOM)
TO GATE OF SCR21 (ON DOM)
TO GATE OF SCR22 (OFF DOM)
PLUG WIRING 475A596

S.O.	IT	CHANGE
G-5GC61	1	
	2	S.O. G-5GC61 CHANGED PER MARKED PRINT W. PITCAIRN 12-21-65 O.S. Kw 12-29-65
	3	S.O. G-GGC80 1Z, 101Z, 201Z, 301Z REMOVED 1R, 2R, 3R, 1C & 2C CHANGED W. PITCAIRN 4-4-66 O.S. Kw 4-4-66
	4	G-GGC80 6R, 16R, 26R & 36R WERE NOT ON 3R, 13R, 23R & 33R WERE 330Ω, 4R, 14R, 24R & 34R WERE 220Ω S.L. 12-29-66 O.S. Kw 12-29-66
	5	6GC7308 DIODE TYPE 1N4864 WERE 1N914 BARNAS 2-10-67 2-16-67 2-17-67
	6	6-GC7308 RES. 7R, 17R, 27R, 37R WERE NOT SHOWN. S.L. 11-29-67 O.S. Kw 12/12/67 1-30-68
S.O. 69230	7	NOTE: "UNLESS OTHERWISE MARKED" WAS ADDED D.A. BREITIN 1-29-69 2/5/69 2-5-69
	8	SCR * WERE CHANGED 4-15-70 4-16-70

GEN. ASS'Y & B/M 658C605

WESTINGHOUSE ELECTRIC CORPORATION

TITLE SCHEMATIC DIAGRAM
INVERTER GATE MODULATOR FOR TYPE 70 + 35

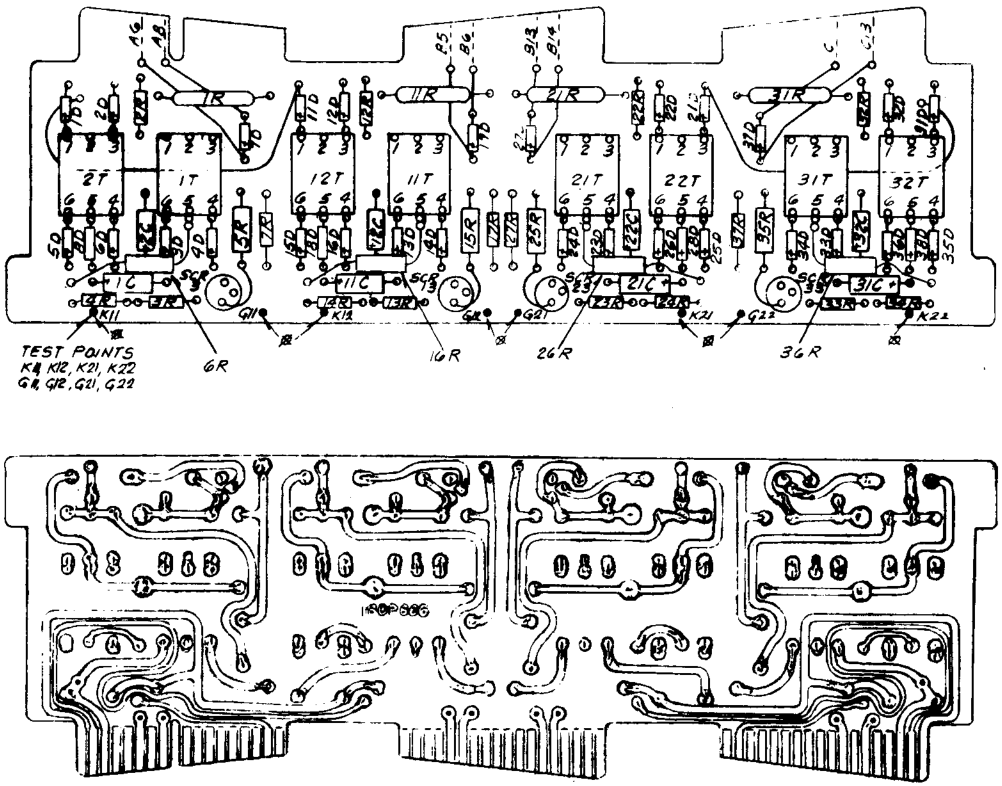
DIMENSIONS IN INCHES—SCALE

DFTM. S. LASKOWSKI 7/1/65 APPD. O.S. Kw 7/15/65
APPD.
APPD. 7-15-65

DIV. & PLANT LOCATION GEN. CONTROL BUFFALO DIVISIONS, BUFFALO, N.Y. U.S.A.

657C350

02 L



SHOP NOTE:- ASSEMBLE TRANSFORMERS WITH NAME PLATE FACING PLUG END
ALTERNATIVELY PIN "1" OF TRANS. HAS BROWN SLEEVE
SCREEN LEAD (BLACK) OF TRANSFORMER TO BE CUT TO
WITHIN 1/8" OF COIL.

TITLE GATE MODULATOR BOARD

DWG. 658C605 SUB × 2 3 4 5 6 7 8 9 10 FINISH CHART

SYM	ITEM	DESCRIPTION MATERIAL DIMENSIONS IN INCHES	PATT. NO OR REF. DWG	FIN CH LINE NO	STYLE NO	REQD	TOOL RECORD
	03	TURRET LUG			2607281-2	8	⊠
	04	RES. 47Ω - 2W - 5%			436A138H31	4	1R, 11R, 21R, 31R
	05	RES. 2.7Ω - 1/2W - 5%			436A132H01	4	7R, 17R, 27R, 37R
	06	RES. 6.8Ω - 1/2W - 5%			436A132H11	4	2R, 12R, 22R, 32R
	07	RES. 30Ω - 5W - W.W.			443A299H42	4	6R, 16R, 26R, 36R
	08	RES. 100Ω - 1/2W - 5%			436A132H39	4	4R, 14R, 24R, 34R
	09	RES. 220Ω - 1W - 5%			436A135H47	8	3R, 5, 13, 15, 23, 25, 33, 35
	10	CAP. 0.22 MFD - 100V.			486A828H29	4	1C, 11C, 21C, 31C
	11	CAP 4.7 MFD - 35V. TAN			454A838H2[illegible]	4	2C, 12C, 22C, 32C
	12	CAP 2.7 MFD - 35V. TAN.			454A838H23	4	2C, 12C, 22C, 32C
	13	DIODE U4 53				4	8D, 18D, 28D, 38D
	14	DIODE			482B466H01	8	1D, 2, 11, 12, 21, 22, 31, 32
	15	SCR			[illegible]811H01	4	SCR 3, 13, 23, 33
	16	TRANS.			[illegible]KQ01	8	1T, 2, 11, 12, 21, 22, 31, 32
	17	PRINTED CIR.			180P666	1	
	19	DIODE 1N4863				20	23D TO 27D, 33D TO 37D, 3D TO 7D, 13D TO 17D
	20	RESISTOR 15Ω - 5W - WW			443A298H35	4	7R, 17R, 27R, 37R
	21	DIODE 1N4863				16	3D TO 6D, 13 TO 16, 23 TO 26, 33 TO 36

GRP	DESCRIPTION	ITEMS ON THIS DWG	REQ
01	PRINTED CIR. ASSY. FOR 150A	03 TO 06, 08 TO 11, 13 TO 17, 20, 21	1
02	PRINTED CIR. ASSY. FOR 35A - 70A	03 TO 10, 12, 14 TO 19	1

BOARD TO BE COATED WITH VARNISH 3210 JB AFTER ELEC. TEST TO SPECIFICATION 480A782

CONTINUED ON SHEET

SCHEMATIC 636C394 (TYPE 150)
SCHEMATIC 657C350 (TYPE 35 & 70)
APPLICATION NOTE 43A[illegible]
TEST INST. 49[illegible]

S.O.	CHANGE
2	6-GC83 RES. 6R, 16R, 26R, 36R WERE NOT SHOWN. S.L. 12-30-66
3	6-GC7308 03 WAS FUNNEL-TURRET LUG 13 WAS REQ 24 14 STYLE # WAS 461A590H22 H22 REQ 4 BARNAS 2-10-67; 13 WAS NOT CANCELLED BARNAS 2-13-67; 11 REPLACED BY IT. 12 B BARNAS 2-16-67
4	6-GC7308 05 11 13 19 20 21 WERE NOT SHOWN. S.L. 12-7-67
5	GC83057 L.S. SZAL 4-17-68
6	GC-83051 L.S. SZAL 5-21-68
7	GC83052 16 14 NOTE WAS REMOVED (B2 CHANGE) 9-4-68
8	GC83051 02 FUNNEL EYELETS REMOVED DRILLING PLAN REMOVED
9	19 DID NOT HAVE 23D TO 27D 33D TO 37D

WESTINGHOUSE ELECTRIC CORPORATION 02

TITLE GATE MODULATOR BOARD ASSEMBLY DIAG.

DIMENSIONS IN INCHES	SCALE
DFTM. S. LASCONSL 5/18/66	APPD A. S. Kew
CHKD S.L.	APPD 5-18-66
DIV & PLANT LOCATION GEN. CON.	BUFFALO DIVISIONS, BUFFALO, N.Y. U.S.A.

658C605