UNCLASSIFIED

TUNING AND LOADING PROCEDURE

for

AN/FRT-39 SERIES (SYNTHESIZED) TRANSMITTERS

by

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Training School

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December, 1963

Revised 3-23-65. Paul E. Shore

Note: ALDC adjustments apply to transmitters manufactured subsequent to May 1964.

A. General:

1. Background:

This expanded procedure has been adapted from a tuning and loading procedure originally prepared by Mr. Virgil Molesberry, TMC Field Engineer.

2. Nomenclature:

For purposes of brevity, TMC nomenclature will be used throughout. For convenient reference, the following cross listing between TMC and Military nomenclatures is provided:

TMC	Military	TMC	Military
CBE	O-714/UR	CSS	O-715/URA-31
TIS-3	TT-39A/UGT	CHG-2	AM-2505A/URA-31
CHL-1	CV-928/URA-31	CMO-1	O-716/URA-31
CLL-1	O-717/URA-31	IPA	AM-2103A/URT
PA	AX-236		

3. Procedures:

Regardless of the mode of operation, the system should be initially tuned and loaded on "carrier". Afterward, the initial adjustments and intelligence controls may be modified, as required, to meet the desired output power and distortion requirements.
Calibration charts prepared "on station" should be used; if these are not available, the tuning charts supplied by TMC should be used as a "starting point". It should be noted that the tuning charts supplied by TMC presuppose a resistive dummy load of 600 ohms (balanced) or 50 ohms, (unbalanced).
This procedure assumes that all components of the exciter frame have been energized for a sufficient period to assure frequency stability and accuracy.

4. Enclosures:

Figure 1: typical calibration chart, 600 ohms balanced.

Figure 2: typical calibration chart, 50 ohms unbalanced.

B. Initial Switch Positions on the Main Frame:

1. Throw the ALARM ON OFF switch to the OFF position.

2. Throw the TUNE OPERATE switch to the TUNE position.

3. Throw the PA SCREEN ON OFF switch to the OFF position.

4. Throw the ALDC ON OFF switch to the OFF position.

5. Rotate the ALDC ADJUST control to the fully CW position.

6. Throw the MAIN POWER ON OFF circuit breaker to the ON position. This will permit the time delay sequence to elapse while the exciter frame is being adjusted.

C. Initial Tuning and Loading of the System on Carrier:

Note:
It will be assumed that a carrier frequency of 11.0015 mcs has been chosen. The transmitter is assumed to be working into a 70 ohm resistive load, unbalanced to ground.

1. On the Sideband Exciter: (CBE)

   a) Throw both USB and LSB selector switches to OFF.

   b) Turn both LSB and USB GAIN controls fully CCW.

   c) Turn the CARRIER LEVEL control fully CW to 0 DB.

2. On the Frequency Amplifier: (CHG-2)

   a) Turn the BAND switch until the desired carrier frequency is included in the indicated frequency range. Note that the indicator window of the control provides three items of information:

      (1) a frequency range covering a 2 mc spread.

      (2) a DIAL NUMERIC: 0, 2, 4, 6, etc., through 30.

      (3) a BAND letter: A, B, C or D.

      Example:

      A carrier frequency of 11.0015 mcs is desired. When the BAND switch is properly placed, the indicated frequency range is 9.75 - 11.75 mcs. The DIAL NUMERIC is 8, and the BAND letter is "C".

b) Subtract the DIAL NUMERIC from the desired output carrier frequency. The result is always a frequency in the range: 1.75 - 3.75 mcs. This result is:

(1) the setting of the MF TUNING control on the CHG-2.

(2) the MASTER OSCILLATOR FREQUENCY setting of the CMO counters.

(3) the setting of the TUNING KCS control on the CMO.

(4) the figure from which the significant KILOCYCLES and HUNDREDS of CYCLES digits are taken for the switch settings on the CLL-1.

Note:

In our example, 11.0015 mcs, subtracting the DIAL NUMERIC, 8, provides a result of 3.0015 mc, or 3001.5 KC.

c) Place the MF TUNING control at 3.0015 mc, approximately.

d) Move the OUTPUT TUNING control until the desired carrier frequency, 11.0015 mcs, appears under the hairline of the OUTPUT MCS dial on scale "C".

e) Place the OUTPUT control in the fully CCW position.

Note:

The SYNC INDICATOR on the CHG-2 will remain ON at all times, as long as this unit is supplied with power and a source of 1 mc signal. To check this control, operate the BAND switch. Between positions, the SYNC indicator should go out.

4. On the Controlled Oscillator: (CLL-1)

a) Move the KILOCYCLES switch to the significant kilocycles digit. In the case of our example: "1".

b) Move the HUNDREDS OF CYCLES switch to the significant hundreds of cycles digit. In the case of our example: "5".

c) Move the SYNC switch successively through positions L-1, L-2 and L-3. In each case, a stationary rectangle should appear on the monitor scope. Place the SYNC switch to the OFF position.

5. On the Controlled Master Oscillator: (CMO)

a) Place the CALIBRATE OPERATE switch to CALIBRATE.

b) Place the pointer of the TUNING KCS control, approximately, to the frequency determined in step C-2-b. In the case of our example: 3.0015 mcs.

c) Unlock the MASTER OSCILLATOR FREQUENCY knob, and rotate it until the counters read a frequency at a 100 KC check point below the frequency obtained in step C-2-b. In the case of our example, the nearest check point below 3.0015 mcs is 2950.0 KCS. Approach this setting from a lower frequency.

Note: Since the CMO dial is offset 250 KC from the actual CMO output frequency, the 100 KC check points actually occur at dial increments of 50 KC. Thus: the check point at 2950 KC is actually a beat between the actual frequency, 3000 KC, and the 30th harmonic of 100 KC.

d) Unlock the red CALIBRATE control (above the counters) and manipulate it carefully until a zero beat indication is obtained on the ZERO BEAT indicator. The SYNC LAMP may or may not blink in synchronism.

e) Carefully rotate the MASTER OSCILLATOR FREQUENCY knob until the counters read the frequency obtained in step C-2-b. Approach this setting from a lower frequency. In the case of our example, the final setting is 3,001.5 KCS. Lock the MASTER OSCILLATOR FREQUENCY knob.

f) Throw the CALIBRATE OPERATE switch to OPERATE.

g) Turn the OUTPUT control CW until a significant indication is obtained on the TUNE FOR MAX meter. One quarter scale will suffice.

h) Carefully peak the indication on the TUNE FOR MAX meter with the TUNING KCS control.

i) The SYNC indicator should be lighted, and the ZERO BEAT indicator should be extinguished. The ADJUST FOR ZERO meter indication is not significant at this time.

j) Manipulate the red CALIBRATE knob slowly in both directions. The needle of the ADJUST FOR ZERO meter should follow, in the opposite direction. When this condition has been obtained, manipulate the red CALIBRATE knob until the ADJUST FOR ZERO meter reads center scale. Lock the adjustment.

Note:

If the indications in steps (i) and (j) cannot be obtained, it may be necessary to "search" with the red CALIBRATE knob in the immediate vicinity until the desired indications are obtained.

6. On the Frequency Amplifier: (CHG-2)

a) Manipulate the MF TUNING control for a peak on the MF TUNING meter. The peak should occur close to the setting made previously. The MF TUNING indication should never be permitted to fall in the RED scale. To prevent this condition, reduce the output of the CMO.

b) Rotate the OUTPUT control CW until a significant indication is obtained on the OUTPUT meter. One quarter scale will suffice.

c) Rotate the OUTPUT TUNING control, to peak the indication on the OUTPUT meter. The peak should occur very close to 11.0015 mcs., on scale "C".

d) Rotate the OUTPUT control CW, to insure that the indication on the OUTPUT meter will reach about three quarters full scale; then return this control to the fully CCW position. The indication on the OUTPUT meter should fall to zero.

This completes the tuning of the exciter frame on "carrier". This procedure is the same, regardless of the type of load connected at the output of the transmitter.

7. On the Main Frame, Meter Panels and IPA, make the following checks:

   a) The PA BIAS meter should be indicating between -200 and -300 volts, and the PA BIAS indicator should be extinguished.

   b) The FILAMENT PRIMARY meter should be reading close to 230 volts, at the RED index. If it is not, adjust the FILAMENT ADJUST control for the proper indication.

   c) The PA SCREEN VOLTAGE, PA PLATE VOLTAGE, PA SCREEN CURRENT, PA PLATE CURRENT, PA PLATE RF and PA OUTPUT meters should not be indicating.

   d) All overload indicator lamps should be extinguished. Should one or more be illuminated, depress, then release the OVERLOAD RESET button.

   e) The IPA BIAS indicator lamp should be extinguished.

   f) The TUNE and AC POWER indicators should be illuminated.

   g) On the IPA, place the MULTIMETER switch to the IPA BIAS position. The indication should be between -80 and -100 volts.

8. After time delay has expired, place the INTERLOCK switch to the NORMAL position. The indicator should be illuminated. If it is not, determine which section of the interlocks is at fault.

9. Preset the following controls, using the prepared calibration charts:

   a) PA TUNE
   b) PA LOAD
   c) PA BAND SWITCH
   d) OUTPUT BALANCE
   e) OUTPUT LOADING
   f) IPA DRIVER BAND
   g) IPA 1st AMPL TUNING
   h) IPA GRID TUNING
   i) IPA MULTIMETER: 1st AMP Ep Rf
   j) IPA TUNING
   k) IPA LOADING
   l) IPA BANDSWITCH
   m) IPA AUX LOADING

10. On the CHG-2, rotate the OUTPUT control slightly CW, until an indication on the OUTPUT meter is obtained.

Note:

The CHG-2 OUTPUT control should be moved slowly and with caution. Very little output from the CHG-2 is required to produce full power output from the transmitter.

11. With the IPA MULTIMETER switch in the 1st AMP Ep RF position, peak the indication with the 1st AMP TUNING control. Under actual operating conditions, the indication will usually not exceed 20 volts. Use the CHG-2 OUTPUT control as required.

12. Place the IPA MULTIMETER switch to the IPA Eg RF position.

13. Peak the indication on the IPA multimeter with the IPA GRID TUNING control. Under actual operating conditions, this indication will not usually exceed 50 volts. Use the CHG-2 OUTPUT control as required.

14. Turn the CHG-2 OUTPUT control fully CCW.

15. Throw the HIGH VOLTAGE ON OFF circuit breaker to the ON position. After a delay of about 5 seconds:

    a) the PA PLATE VOLTAGE meter should read 7.5 KV.

    b) the HV ON indicator on top of the transmitter should come on.

    c) the PLATE ON indicator should come on.

16. On the IPA:

    a) place the MULTIMETER switch to the IPA Esg DC position; the indication should be 200 volts DC.

    b) place the MULTIMETER switch to the IPA Ep DC position; the indication should be in excess of 3.5 KV.

17. Carefully increase the output of the CHG-2 until an indication of plate current is noted on the IPA PLATE CURRENT meter.

18. Adjust the IPA TUNING control for a dip on the IPA PLATE CURRENT meter.

19. Carefully increase the output of the CHG-2 until an indication is noted on the PA PLATE CURRENT meter.

20. Manipulate the PA TUNE control for a dip on the PA PLATE CURRENT meter.

21. Reduce the output of the CHG-2 to zero.

22. Throw the PA SCREEN ON OFF switch to ON. The PA SCREEN VOLTAGE meter should indicate 600 volts.

23. Throw the TUNE OPERATE switch to OPERATE.

    a) the TUNE indicator should go out and the OPERATE indicator should come on.

    b) the PA SCREEN VOLTAGE meter should indicate 1200 V.

    c) the PA PLATE CURRENT meter should indicate very close to .5 ampere. If it does not, adjust the PA BIAS ADJUST control for the proper indication.

    d) the IPA PLATE CURRENT meter should indicate very close to 200 milliamperes. If it does not, manipulate the IPA BIAS ADJUST for the proper indication.

    e) with the IPA MULTIMETER switch in the IPA Esg DC position, the indication should be 400 V.

    f) with the IPA MULTIMETER switch in the IPA Ep DC position, the indication should be close to 3.5 KV.

24. Carefully increase the output of the CHG-2 until the IPA plate current increases above the static value; an indication of about 225 milliamperes is sufficient.

    Note:

    In this and subsequent steps, care must be taken to avoid certain voltage and current limits. These limits, as indicated by the appropriate meters, are,

    a) PA PLATE RF — 6 KV

    b) PA PLATE CURRENT — 1.75 amperes

    c) PA SCREEN CURRENT — 50 ma. (OVLD trips at 80 ma.)

    d) IPA PLATE CURRENT — 400 ma. (OVLD trips at 600 ma.)

    e) IPA SCREEN CURRENT — 25 ma. (OVLD trips at 30 ma.)

    f) PA OUTPUT — (if transmitter is connected for unbalanced output)

    8.4 amperes with 70 ohm load.
    10 amperes with 50 ohm load.

25. Alternately manipulate the IPA TUNING and IPA LOADING controls until, at resonance, the IPA PLATE CURRENT meter reads about 300 ma. Each time the IPA PLATE CURRENT reading is increased with the IPA LOADING control, dip the indication with the IPA TUNING control until the desired result is achieved. Adjust the drive, as required, with the OUTPUT control on the CHG-2. During this step it might be advisable to keep the IPA MULTIMETER switch in the IPA Isg DC position, to insure that an IPA screen current of 30 ma. is not exceeded. In addition, it might be required to adjust the PA TUNE and PA LOAD controls, to avoid excessive indications in the final power amplifier.

26. Alternately manipulate the PA TUNE and PA LOAD controls until the PA PLATE CURRENT meter reads in the region of 1.0 - 1.75 amperes, and the PA PLATE RF meter reads in the region 2.0 - 5.0 KV.

Note:

It may be necessary to refine the positions of the OUTPUT BAL and OUTPUT LOADING controls, depending on the frequency, and the manner in which the transmitter output is connected. If the transmitter is connected for unbalanced output, the PA OUTPUT meter will read 8.4 amperes into a 70 ohm load or 10 amperes into a 50 ohm load, when the power output is 5 KW.
It may also be necessary to refine the IPA TUNING and IPA LOADING adjustments slightly, since tuning the PA may throw the IPA slightly out of tune.
If the transmitter is connected for 600 ohm balanced output, two external ANTENNA CURRENT ammeters will be connected in the output transmission line, one in series with each leg. The OUTPUT BAL control should be manipulated until the external current meters dip in opposite directions; the OUTPUT BAL control should then be refined until equal currents are indicated in each meter. The PA OUTPUT meter is not connected when the transmitter is set up for balanced operation.
In balanced operation, output power is measured as follows: "multiply the load resistance by the square of the current in one of the external ammeters."
Thus: 2.9 amperes in one of the meters (both meters reading equally) with a 600 ohm balanced load represents an average power of 5 KW.

27. Upon completion of loading, note carefully the reading of the PA PLATE RF meter.

28. If it is desired to test the ALDC circuits, proceed as follows:

a) place the ALDC control slightly clockwise, until the switch is heard to click "ON".

b) move the ALDC control slowly clockwise, noting the PA PLATE RF meter. At some point, the PA PLATE RF indication should commence to decrease. Return the ALDC control fully CCW to OFF.

29. Monitor the panel meters, and compare the readings with those in the table below. The table indicates the approximate minimum and maximum values to be expected under normal conditions:

CHG-2 OUTPUT	usually less than 1/4 scale.
PA PLATE CURRENT	1.0 - 1.75 amperes.
PA SCREEN CURRENT	10 - 50 ma.
PA PLATE RF	2 - 5 KV
IPA I sg DC	5 - 20 ma.
IPA 1st AMP Ep RF	10 - 20 V.
IPA Eg RF	20 - 50 V.
IPA Ep RF	600 - 1500 V.
PA Eg RF	90 - 300 V.

30. Return the OUTPUT control on the CHG-2 fully CCW, to prepare the transmitter for the transmission of actual intelligence.

SBG-1			IPA STAGE								PA STAGE					TEST RESULTS							
FREQ MC	BAND	CMO	IPA BAND	DRIVER BAND	1ST AMP TUNING	IPA GRID TUNING	IPA TUNING	IPA LOADING	IPA LOAD POS	IPA PLATE CURRENT	FINAL BAND	PA TUNE	PA LOADING	OUTPUT BAL	OUTPUT LOADING	10KW LOAD CURRENT	10KW S/D DB	5KW LOAD CURRENT	5KW S/D DB	DC PLATE CURRENT	DC SCREEN CURRENT	% OF UN/BAL	PA PLATE RF
2	0	2000	2-2.5	2-4	0	2	014	050	1	300	2-3	604	450	490	900	2.9		2.1		1.0	24		2.2
2.5	0	2500	2-2.5	2-4	3	4	052	081	2	260	2-3	371	256	433	900	2.9		2.1		1.1	24		2.4
2.5	0	2500	2.5-3	2-4	3	4	052	081	2	260	2-3	371	256	433	900	2.9		2.1		1.1	24		2.4
3	0	3000	2.5-3	2-4	5	6	009	081	2	210	3-4	304	340	379	900	2.9		2.1		1.1	18		2.5
3	0	3000	3-4	2-4	5	6	050	126	2	350	3-4	304	340	379	900	2.9		2.1		1.1	18		2.5
4	2	2000	4-6	2-4	9	8	074	091	2	300	4-6	196	240	327	900	2.9		2.1		1.1	20		2.8
4	2	2000	4-6	4-8	0	0	074	091	2	300	4-6	196	240	327	900	2.9		2.1		1.1	20		2.8
6	4	2000	4-6	4-8	5	6	098	110	3	320	4-6	106	040	295	800	2.9		2.1		1.3	20		3.0
6	4	2000	6-8	4-8	5	6	076	001	3	310	6-8	228	225	293	800	2.9		2.1		1.2	20		4.0
8	6	2000	6-8	4-8	9	10	094	001	3	260	6-8	154	150	290	800	2.9		2.1		1.1	14		4.2
8	6	2000	8-12	8-16	0	0	076	004	3	390	8-11	221	177	277	364	2.9		2.1		1.5	28		5.0
11	8	3000	8-12	8-16	4	5	096	004	3	230	8-11	136	223	295	092	2.9		2.1		1.1	12		5.1
11	8	3000	8-12	8-16	4	5	096	004	3	230	11-15	176	313	295	090	2.9		2.1		1.1	12		5.2
12	10	2000	8-12	8-16	5	6	101	050	3	210	11-15	159	242	290	090	2.9		2.1		1.1	16		5.7
12	10	2000	12-16	8-16	5	6	088	040	3	200	11-15	159	242	290	090	2.9		2.1		1.1	16		5.7
15	12	3000	12-16	8-16	8	10	099	091	3	350	11-15	109	104	294	001	2.9		2.1		1.2	10		5.0
15	12	3000	12-16	8-16	8	10	099	091	3	350	15-19	114	183	292	001	2.9		2.1		1.1	12		5.2
16	14	2000	12-16	8-16	9	10	107	060	3	250	15-19	152	151	284	001	2.9		2.1		1.2	10		5.2
16	14	2000	16-20	16-20	5	6	088	023	3	290	15-19	152	151	284	001	2.9		2.1		1.2	10		5.2
19	16	3000	16-20	16-20	7	8	096	043	3	210	15-19	094	119	282	001	2.9		2.1		1.1	12		6.0
19	16	3000	16-20	16-20	7	8	096	043	3	210	19-24	158	157	267	001	2.9		2.1		1.1	12		5.5
20	18	2000	16-20	16-20	8	8	099	050	3	220	19-24	148	147	265	001	2.9		2.1		1.0	14		6.5
20	18	2000	20-28	20-28	4	6	086	019	3	240	19-24	148	147	265	001	2.9		2.1		1.0	14		6.5
20	18	2000	20-28	20-28	4	6	086	019	3	240	19-24	148	147	265	001	2.9		2.1		1.0	14		6.5
24	22	2000	20-28	20-28	6	8	095	006	3	200	19-24	091	082	216	001	2.9		2.1		1.1	10		6.0
24	22	2000	20-28	20-28	6	8	095	006	3	200	24-28	190	143	236	001	2.9		2.1		1.1	12		6.0
28	26	2000	20-28	20-28	9	10	101	062	3	210	24-28	142	220	185	001	2.9		2.1		1.2	10		6.0

TEST CONDITIONS:

LOAD

600Ω

70Ω UNBALANCE

REMARKS:

10KW LOAD CURRENT
5KW LOAD CURRENT
READ ON EXTERNAL
LINE AMMETER

DATE : 4-15-63

MFGR No. 41624

SERIAL No. 8995

TESTED BY _____

APPROVED BY _____

MODEL: GPT-10KR-5

THE TECHNICAL MATERIEL CORP
MAMARONECK NEW YORK

E16.1
600Ω BAL.

CH-189

MC FOR 167

SBG-1			IPA STAGE								PA STAGE					TEST RESULTS							
FREQ MC	BAND	CMO	IPA BAND	DRIVER BAND	1ST AMP TUNING	IPA GRID TUNING	IPA TUNING	IPA LOADING	IPA LOAD POS	IPA PLATE CURRENT	FINAL BAND	PA TUNE	PA LOADING	OUTPUT BAL	OUTPUT LOADING	10KW LOAD CURRENT	10KW S/D DB	5KW LOAD CURRENT	5KW S/D DB	DC PLATE CURRENT	DC SCREEN CURRENT	% OF UN/BAL	PA PLATE RF
2	0	2000	2-2.5	2-4	0	0	012	125	1	400	2-3	551	361	300	900	10		7		1.3	30		2.0
2.5	0	2500	2-2.5	2-4	3	5	053	100	2	390	2-3	316	404	300	900	10		7		1.3	34		2.2
2.5	0	2500	2.5-3	2-4	3	5	036	065	2	390	2-3	313	404	300	900	10		7		1.3	30		2.2
3	0	3000	2.5-3	2-4	5	6	062	100	2	325	3-4	278	608	300	800	10		7		1.4	25		2.5
3	0	3000	3-4	2-4	5	6	053	063	2	330	3-4	282	633	300	800	10		7		1.4	28		2.5
4	2	2000	4-6	2-4	4	9	073	070	2	320	4-6	276	609	300	800	10		7		1.2	26		2.7
4	2	2000	4-6	4-8	0	0	074	070	2	330	4-6	280	669	300	800	10		7		1.2	30		3.4
6	4	2000	4-6	4-8	5	7	097	051	3	235	4-6	179	120	300	800	10		7		1.3	16		3.6
6	4	2000	6-8	4-8	5	7	075	000	3	310	6-8	243	208	300	800	10		7		1.2	20		4.2
8	6	2000	6-8	4-8	9	9	092	052	3	250	6-8	173	074	300	800	10		7		1.1	22		5.0
8	6	2000	8-12	8-16	0	0	076	004	3	320	8-11	251	132	300	800	10		7		1.2	24		5.1
11	8	3000	8-12	8-16	4	6	093	061	3	290	8-11	163	057	003	700	10		7		1.4	22		5.7
11	8	3000	8-12	8-16	4	6	093	061	3	290	11-15	209	091	003	700	10		7		1.4	24		5.6
12	10	2000	8-12	8-16	5	6	098	050	3	250	11-15	188	073	003	600	10		7		1.3	16		5.0
12	10	2000	12-16	8-16	5	6	087	005	3	260	11-15	188	073	003	600	10		7		1.3	16		5.0
15	12	3000	12-16	8-16	7	8	097	040	3	250	11-15	149	029	003	500	10		7		1.2	11		4.1
15	12	3000	12-16	8-16	7	8	097	040	3	250	15-19	197	061	003	500	10		7		1.1	12		4.4
16	14	2000	12-16	8-16	9	9	105	036	3	240	15-19	185	048	003	500	10		7		1.2	12		4.0
16	14	2000	16-20	16-20	5	6	086	034	3	300	15-19	185	048	003	500	10		7		1.1	12		4.0
19	16	3000	16-20	16-20	7	8	094	014	3	300	15-19	144	029	003	500	10		7		1.3	16		5.2
19	16	3000	16-20	16-20	7	8	094	014	3	300	19-24	183	059	003	500	10		7		1.3	18		5.4
20	18	2000	16-20	16-20	8	8	096	034	3	320	19-24	162	069	003	200	10		7		1.2	14		5.0
20	18	2000	20-28	20-28	4	6	089	008	3	360	19-24	162	069	003	200	10		7		1.2	14		5.0
20	18	2000	20-28	20-28	4	6	084	008	3	360	19-24	162	069	003	200	10		7		1.2	14		5.0
24	22	2000	20-28	20-28	6	7	092	023	3	290	19-24	124	038	003	200	10		7		1.1	10		4.3
24	22	2000	20-28	20-28	6	7	092	023	3	300	24-28	195	099	003	200	10		7		1.0	12		5.1
28	26	2000	20-28	20-28	9	9	099	053	3	285	24-28	156	085	003	200	10		7		1.0	20		6.3

TEST CONDITIONS:

LOAD

☐ 600Ω

▨ 50Ω UNBALANCE

REMARKS:

DATE: 6-4-63

MFGR No.: 41696

SERIAL No.:

TESTED BY

APPROVED BY

MODEL: GPT-10K-R

THE TECHNICAL MATERIEL CORP
MAMARONECK NEW YORK

FIG. 2
50Ω UNBAL.
PAGE 12

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D. The Application of Intelligence in the Various Modes of Operation to the Model SBG-1 or SBG-2 Sideband Generator Systems.

1. Background:

a) Sufficient information exists on the tuning of the Models SBG-1 and SBG-2 Sideband Generator systems on "carrier". Unfortunately, a detailed sequence for the proper tuning of these systems in other modes is not generally available.

b) Much confusion exists as to the proper settings of the intelligence controls of these systems, when a Panoramic Analyzer is not available for an examination of the transmitted spectrum.

c) Misunderstandings exist as to the exact frequency at which the system must be "synthesized" in the FAX, CW and FSK modes of operation.

d) This discussion will attempt to resolve the more common misunderstandings and misconceptions.

2. System Differences:

a) There is one major difference between the SBG-1 and SBG-2 systems:

(1) the SBG-1 system contains a Model CBE-1 Sideband Exciter, which has an audio bandpass of 350 to 7500 cycles per second, per sideband. Thus, a total bandpass of about 15 KC is possible with this unit.

(2) the SBG-2 system contains a Model CBE-2 Sideband Exciter, which has an audio bandpass of 250 to 3500 cycles per sideband. Thus, a total bandpass of about 7000 cycles is possible with this unit.

b) The Model TIS-3 Tone Intelligence Unit is not, in the strictest sense, a unit of the Sideband Generator system; it may be included in the exciter section of a particular transmitter, however. When the TIS-3 is part of a system, two 600 ohm audio lines from the primary sources of intelligence are connected to this unit. The Channel 1 and Channel 2 EXCITER switches on the TIS-3 connect either the input 600 ohm audio lines or the output of the TIS-3 in the FAX, FSK or CW modes, to the Channel 1 and Channel 2 inputs of the associated Sideband Exciter Model CBE-1 or CBE-2.

c) When the TIS-3 is used in the CW mode, the unit delivers, to either the Channel 1 or Channel 2 output terminals, a keyed 1 KC tone. This 1 KC tone will be above or below the "carrier" frequency by an amount 1 Kilocycle.

d) When the TIS-3 is not included in the system, the CW mode may be accommodated, if desired, by "keying" the Controlled Master Oscillator (CMO). A " CMO KEYLINE " is brought out to the interconnecting terminal board of the transmitter; this keyline utilizes a "dry contact" type of keying, which enables or disables the RF amplifier circuits of the CMO. Thus, the 2-4 mc frequency from the CMO is keyed.

3. Terminology:

a) CARRIER FREQUENCY:

The carrier frequency is that position in the RF spectrum reserved for the "carrier" whether the carrier is present or not.

b) ASSIGNED FREQUENCY:

The assigned frequency is a reference frequency designed to identify or reserve a given portion of the RF spectrum. Most U.S. Government agencies define the assigned frequency as: "THE CENTER OF A FREQUENCY BAND ASSIGNED TO A STATION". The "assigned" frequency and the "carrier" frequency may or may not be one and the same. Often the assigned frequency is followed by the carrier frequency in parenthesis for clarification.

EXAMPLES:

(1) If the transmission is an upper sideband, with completely suppressed carrier, and the total audio bandpass extends to 3000 cycles, the assigned frequency is 1500 cycles above the non existent carrier frequency.

(2) If the transmission is an independent sideband (ISB) transmission, with audio intelligence from 350 to 7500 cycles per sideband, with or without carrier suppression, the assigned frequency and the carrier frequency are one and the same, since both occupy the center of the transmitted spectrum.

4. Adjustments and Levels in the Sideband Exciter (CBE):

a) Connect an Audio Oscillator with an output impedance of 600 ohms to the Channel 1 input terminals of the CBE. Set the frequency of the oscillator for a single tone output anywhere in the bandpass; for example: 935 cycles, 1 KC, 2 KC, 2805 cycles, etc..

b) On the CBE:

(1) place the LSB selector switch to OFF.

(2) place the LSB GAIN control to the fully CCW position.

(3) place the USB selector switch to Channel 1.

(4) place the USB GAIN control to the fully CW position.

(5) place the CARRIER LEVEL control fully CCW to OFF.

c) Adjust the output of the Audio Oscillator until the USB meter on the CBE reads 0 DB (100%).

d) With a Ballantine Model 314 or equivalent VTVM, measure the output of the Audio Oscillator; it should be close to .025 volt.

(1) The input power, then, is:

$$P_{IN} = \frac{E_{IN}^2}{Z_{IN}} = \frac{(2.5\times10^{-2})^2}{6\times10^2} = \frac{6.25\times10^{-4}}{6\times10^2} \cong 1\times10^{-6} = 1\ \mu\text{watt}$$

(2) The input power, referred to 0 DBM, is:

$$DBM = 10\log\frac{1\times10^{-3}}{P_{IN}} = 10\log\frac{1\times10^{-3}}{1\times10^{-6}} = 10\log 1000 = 10\cdot3 = -30\ DBM$$

e) Then: with the USB meter reading 100% or 0 DB, for full power output of the CBE, the absolute input power is 1 u watt or -30 DBM.

f) Connect a 70 ohm resistive dummy load to J-202, the 250 KC OUTPUT jack on the CBE. Measure, with an AC VTVM, the voltage across this load; it should be close to 120 millivolts.

(1) The output power, then, is:

$$P_{OUT} = \frac{E_0^2}{Z_0} = \frac{(1.2\times10^{-1})^2}{7\times10^1} = \frac{1.44\times10^{-2}}{7\times10^1} \cong .2\times10^{-3} = 200\ \mu\text{watts}$$

(2) The output power, referred to 0 DBM, is:

$$DBM = 10\log\frac{1\times10^{-3}}{P_{OUT}} = 10\log\frac{1\times10^{-3}}{2\times10^{-4}} = 10\log 5 = -7\ DBM$$

g) If the input power is 1 u watt (-30DBM), and the output power is 200 u watts (-7 DBM), the maximum gain of the CBE is 23 DB.

h) To summarize: using single sideband (USB), fully suppressed carrier, the voltage output of the CBE is 120 mv; this represents 200 u watts into 70 ohms. The indication on the USB meter is 100% (0 DB). This represents the full output power of the CBE.

i) On the CBE:

(1) place the USB selector switch to the OFF position, and place the USB GAIN control fully CCW.

(2) place the LSB selector switch to the Channel 1 position, and place the LSB GAIN control fully CW.

(3) leave the CARRIER LEVEL control fully CCW at OFF.

j) With the same output level and frequency from the Audio Oscillator, the LSB meter on the CBE should indicate 0 DB (100%), and the voltage across the 70 ohm load at J-202 should be close to 120 millivolts. These indications establish that, using single sideband (LSB), fully suppressed carrier, the output voltage of the CBE is 120 mv, representing a power of 200 u watts. This is the full output power of the CBE.

k) On the CBE:

(1) place both USB and LSB selector switches to OFF.

(2) place both USB and LSB GAIN controls fully CCW.

(3) place the CARRIER LEVEL control fully CW to 0 DB.

The voltage at J-202 should again be close to 120 mv, indicating that, with fully inserted carrier only, the CBE delivers its full output power of 200 u watts.

Note: If the indications in steps 4 (a) through (k) cannot be obtained, WITHIN REASONABLE LIMITS, conduct an alignment of the CBE, with particular attention to:

a) R-213, C-216	USB Carrier Balance controls.
b) R-244, C-233	LSB Carrier Balance controls.
c) R-237	Combining Network Balance.
d) R-236	Carrier Insert control.
e) R-216	USB Meter calibration.
f) R-247	LSB Meter calibration.

5. MF an RF OUTPUT Indications on Frequency Amplifier Model CHG-2:

a) Disconnect the 70 ohm load from J-202 on the CBE; leave the Audio Oscillator input connected as before. Reconnect the CBE output into the Sideband Generator System.

b) Place both LSB and USB selectors on the CBE to OFF; place both LSB and USB GAIN controls fully CCW. Place the CARRIER LEVEL control fully CW to 0 DB.

c) Tune the Sideband Generator System to any frequency within its range. Note the MF tuning meter on the CHG-2. The MF indicator can be changed by varying either the CARRIER LEVEL control on the CBE or the OUTPUT CONTROL on the CMO. With full carrier inserted, the CBE is delivering 120mv to the CHG-2, and since full carrier is desired, the CARRIER LEVEL control on the CBE should not be touched. The OUTPUT CONTROL on the CMO should be adjusted to provide an MF indication just to the LEFT of the RED index on the MF tuning meter. This will occur when the CMO OUTPUT meter reads approximately '3'. At this time the CMO is injecting 1.0 volt rms into the MF Balanced Modulator. Under these conditions, the MF circuits are operating at optimum efficiency, without being OVERDRIVEN.

d) Set the CHG-2 OUTPUT control for an arbitrary indication, say "4", on the CHG-2 OUTPUT meter.

e) Place the CARRIER LEVEL control on the CBE fully CCW to MIN. The MF and RF output indications on the CHG-2 should fall to ZERO.

f) Place the LSB selector switch on the CBE to channel 1; place the LSB GAIN control fully CW. With 0.025 volts still inserted from the audio oscillator, the MF and RF output indications obtained in the previous steps should be repeated.

g) Place the LSB selector to OFF, and the LSB GAIN control fully counter clockwise. Place the USB selector to channel 1, and the USB GAIN control fully CW. The MF and RF output indicators should again indicate as in the previous steps.

NOTE:
Due to minor unbalances, aging components, meter calibrations,etc., the indications obtained in steps 5 (c) through (g) may vary slightly. If, in any step, the MF tuning meter indicates in the RED, reduce the OUTPUT control onthe CMO to bring the indication to the left of the RED INDEX.

6. SUMMARY:

a) The FULL POWER output of the CBE is realized when the CBE output voltage is 120mv.

b) The MF circuits of the CHG-2 are operating properly when the injection voltage, (2to 4 mcs) from the CMO is supplied at 1.0 volt, and the injection from the CBE, (250 Kcs) is supplied at 120 milivolts rms. Under these conditions, the MF tuning meter reads just to the left of the RED INDEX.

c) The OUTPUT meter on the CMO reads approximately "3" when the CMO is supplying the injection at 1.0 volt.

d) It should be apparent that, under any and all conditions, the voltage output of the CBE should be 120 millivolts. This means that, for example, with an independent sideband transmission with partially re-inserted carrier, the aggregate voltage out of the CBE, as a result of the carrier, LSB intelligence and the USB intelligence should not exceed 120 millivolts.

e) The chart below shows the relationships among DB, percentage, and FULL RF output voltage of the CBE, referred to a MAXIMUM of 120 millivolts.

VOLTAGE	PERCENT	DB
120mv	100	0
107	89	-01
95	79	-02
84	70	-03
75	63	-04
67	56	-05
60	50	-06
54	45	-07
48	40	-08
42	35	-09
38	32	-10
34	28	-11
30	25	-12
27	22	-13
24	20	-14
21	18	-15
19	16	-16
17	14	-17
15	13	-18
13	11	-19
12	10	-20
4	3	-30
1	1	-40

NOTE: Decimals rounded off to the nearest whole number.

7. Calculating the Required CBE Intelligence Levels:

NOTE:
The Chart on page 19 is used as a reference. Calculations are rounded off to the closest points on the chart.

EXAMPLE #1:

Required: SSB, (USB), with Carrier at 0 DB.

E usb + E carr. = 120mv (E carr.= E usb)

2 E usb = 120 mv ∴ E usb = $\frac{120\ mv}{2}$ = 60 mv

E usb = 60 mv = 50% = - 6 DB (usb level)
E car.= $\frac{60\ mv = 50\%}{120\ mv = 100\%}$ = - 6 DB (carrier level)

EXAMPLE #2

Required: AME: (DSB with Carrier at + 6 DB).

E usb + E lsb + E carr. = 120 mv (E usb = E lsb)

E carr. = 2 E usb (carrier at + 6 DB)

2 E sb + 2 E sb(carr.) = 120 mv ∴ 4 E sb = 120 mv.

E sb = $\frac{120mv}{4}$ = 30mv ∴

Eusb = 30mv = 25% = -12 DB
Elsb = 30mv = 25% = -12 DB
Ecarr. = $\frac{60mv = 50\%}{120mv = 100\%}$ = - 6 DB

EXAMPLE #3

Required: Independent Sideband: LSB 3 DB below USB;
Carrier at -10 DB with respect to USB.

E usb + E lsb + E carr. = 120mv

Lsb @ -3 DB of Usb = 0.7 Usb
Car @ -10DB of Usb = 0.32 Usb

0.7 Eusb + 0.32 Eusb + Eusb = 120mv ∴

2.03 Eusb = 120mv ∴ Eusb = 60mv

E usb = 60mv = 50% = -6 DB
E lsb = 42mv = 35% = -9 DB
E car = $\frac{19mv = 16\%}{121mv = 100\%}$ = -16 DB

8. Preparation of the system for the transmission of Intelligence;

Final ALDC adjustments:

a) Disconnect the test audio oscillator from the LINE 1 input terminals.

b) Connect the audio lines from the external sourse to the line 1 and LINE 2 input terminals.

c) On the CBE:

(1) place the LSB and USB selectors to CHANNEL 1

(2) place the carrier level control fully CCW to MIN.

(3) place both LSB and USB GAIN controls fully CCW

d) On the TIS-3:

(1) Place the FUNCTION switch to CW

(2) Place the TEST switch to MARK

(3) Place the CHANNEL 1 EXCITER switch to CW-FAX-FSK

(4) Move the output level adjust clockwise until the output level METER reads -20 DB. The TIS-3 is now delivering, to the CHANNEL 1 input on the CBE, a 1 Kc audio tone.

e) On the CBE:

(1) Place the LSB and USB selectors to CHANNEL 1

(2) Move both USB and LSB GAIN controls CW for a reading of 50% (-6 DB), on each METER.

f) Bring up the transmitter until an average output power of 5.0 KW is indicated. With two EQUAL tones applied, Peak Envelope Power (PEP), is 10.0 KW. Note carefully the reading of the PA PLATE RF meter.

g) Throw the ALDC control CW to ON.

h) Slowly move the ALDC control CW observing the PA PLATE RF meter. When the indicator commences to drop, return the ALDC control slowly to the point where NO drop is observed. The ALDC circuits are now set to operate when the PEP tends to EXCEED 10.0 KW.

i) Reduce the output of the CHG-2 to zero.

j) Apply intelligence as required, at levels determined by the methods described in this publication.

k) Bring the CHG-2 output up slowly, until the PA PLATE RF meter indicates the setting reached in step (8f) (10 KW PEP).

9. Miscellaneous Considerations:

a) Depending on the Model of the transmitter, and the modifications incorporated, the output power may be read on an ammeter, a power meter calibrated for average power, or, in later modifications, a meter calibrated for PEP.

b) CW Operation:

(1) Keying via "CMO KEYLINE".

(a) in this type of operation, "dry keying" is used, to enable or disable the RF amplifier circuits of the CMO.

(b) the CARRIER LEVEL control on the CBE is at 0 DB.

(c) both sideband selectors on the CBE are in the OFF position.

(d) the "carrier frequency", "assigned frequency" and "synthesizer frequency" are all one and the same.

(2) Keying via the TIS-3:

(a) in this type of operation, the TIS-3 delivers a keyed 1 KC tone to either Channel 1 or Channel 2 inputs of the CBE.

(b) the CARRIER LEVEL control on the CBE is placed fully CCW at MIN.

(c) the medium frequency balanced modulator receives a 1 KC tone, one kilocycle removed from the non existent 250 KC "carrier".

(d) unless, in the initial tuning of the SBG system, the result of the subtraction of the DIAL NUMERIC from the desired output frequency is modified by an amount 1 KC, the output frequency will be in error by that amount.

Example:

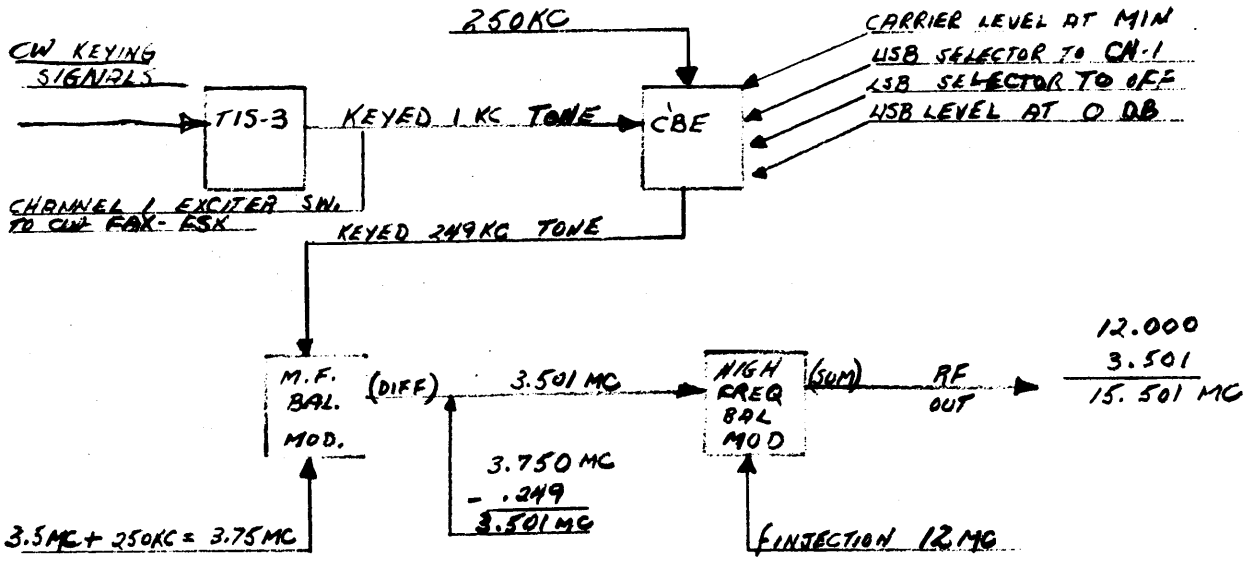
Required: CW Operation only, via the TIS-3.
Assigned Frequency: 15.5 mcs.

a) CHG-2 Bandswitch: 11.75 - 15.75 mcs; N = 12.

b) Ordinarily, the following subtraction would be made:

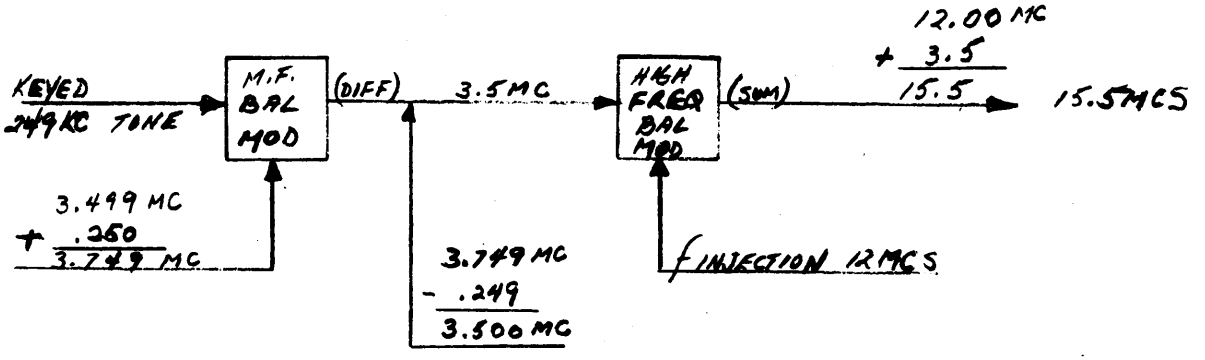
RF output frequency	15.5	mcs
Dial Numeric	- 12.0	
CMO, MF, settings	3.5	mcs

c) The block diagram below shows the resultant output frequency to be in error by 1 KC:



d) In the preceding example, if the result of the subtraction of the Dial Numeric from the RF output frequency is reduced by 1 KC, the correct RF output frequency will be produced.

RF output frequency	15.5	mcs
Dial Numeric	- 12.0	
	3.5	mcs: minus 1 KC = 3.499 mc.



c) FSK and FAX Operation with TIS-3:

(1) the international standard "center" frequency for facsimile transmission is 1900 cps. When the transmitter is to be used for FAX transmission only, using the TIS-3:

(a) the TIS-3 will deliver, to either channel, a 1900 cycle center frequency. The instantaneous frequency will shift about this point.

(b) the FAX signal from the TIS-3 should be selected by the USB selector on the CBE.

(c) the result of the subtraction of the Dial numeric from the required output frequency should be reduced by an additional 1900 cycles, to insure that the final output "assigned" frequency is correct.

(2) the international standard "center" frequency for frequency shift teletype signals is 2550 cycles. When the transmission is to be FSK only, using the TIS-3:

(a) the TIS-3 will deliver, to either channel, a 2000 or 2550 cycle center frequency. The MARK and SPACE frequencies will shift about the center frequency selected.

(b) the FSK signal from the TIS-3 should be selected by the USB selector of the CBE.

(c) with the Model SBG Sideband Generator system, the 2000 cycle center frequency rather than the 2550 cycle center frequency should be selected, since the system is not capable of precision frequency control in less than 100 cycle steps.

(d) the result of the subtraction of the Dial numeric from the required output frequency should be reduced by an additional 2000 cycles, to insure that the final output "assigned" frequency is correct.

d) Independent Sideband Operation, with the Output of the TIS-3 on one Sideband:

Under these conditions, the "carrier", "assigned" and "synthesized" frequencies are one and the same. The result of the subtraction of the Dial Numeric should not be altered.