APPENDIX 9

PLL DATA SHEETS

TWELVE (12) PAGES LC7185 DATA SHEETS FOLLOW THIS SHEET

CMOS IC

LC7185-8750

CB Transceiver PLL Frequency Synthesizer and Controller

Overview

This 27 MHz band, PLL frequency synthesizer LSI chip is designed specifically for CB transceivers.
The specifications are suited for use in U.S.A.(FCC).

Functions

The LC7185-8750 incorporates PLL circuitry and a controller for CB applications on a single CMOS chip. The controller handles the PLL circuitry, frequency data ROM, channel preset/recall RAM, and LED display driver. It also supports channel scan, channel preset/recall, and emergency channel call.

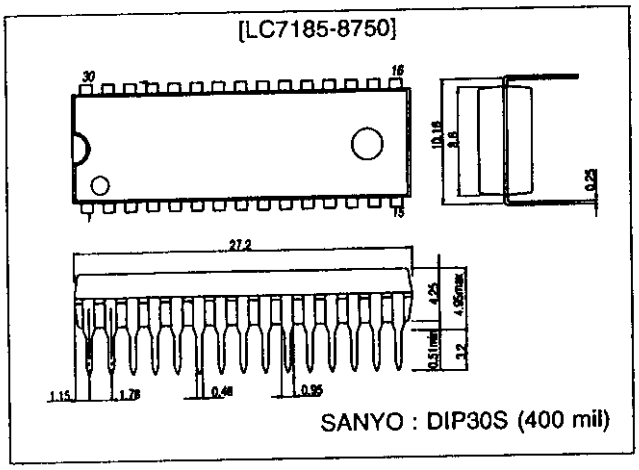
Features

1. A built-in programmable divider for the 16 MHz VCO
2. Transmission is inhibited when the PLL is unlocked (digital lock monitor).
3. Direct channel 9 or 19 selection (sliding switch)
4. A 7-segment, 2-character LED display
5. "PA" is displayed in public announcement mode.
6. Output beep-tone control circuitry
7. Up to 5 channel settings can be stored in memory.
8. 4 × 3 key matrix implementation

Package Dimensions

unit : mm

3061-DIP30S



Specifications

Absolute Maximum Ratings at Ta = 25°C, V_{SS} = 0 V

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{DD} max	Pin V_{DD}	−0.3 to +9.0	V
Input voltage	$V_{IN}1$ max	Pins $\overline{HOLD}$, $\overline{TX}$	−0.3 to +15	V
	$V_{IN}2$ max	Input pins other than $V_{IN}1$ max	−0.3 to V_{DD} +0.3	V
Output voltage	V_O1 max	Pins SA, SB, SC, SD, SE, SF, SG, D1, D2	−0.3 to +15	V
	V_O2 max	Pins $\overline{UL}$, BEEP	−0.3 to +15	V
	V_O3 max	Pin PD	−0.3 to V_{DD} +0.3	V
	V_O4 max	Output pins other than mentioned above	−0.3 to V_{DD} +0.3	V
Output Current	I_O1 max	Pins SA, SB, SC, SD, SE, SF, SG	0 to +30	mA
	I_O2 max	Pins D1, D2	0 to +10	mA
	I_O3 max	Pins $\overline{UL}$	0 to +20	mA
	I_O4 max	Pin BEEP	0 to +10	mA
Allowable power dissipation	Pd max	(Ta ≦ 85°C)	350	mW
Operating temperature	Topr		−40 to +85	°C
Storage temperature	Tstg		−55 to +125	°C

SANYO Electric Co.,Ltd. Semiconductor Bussiness Headquarters
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

Allowable Operating Conditions at Ta = –40 to +85°C, V_{SS} = 0 V

Parameter	Symbol	Conditions	min	typ	max	Unit
Supply voltage	V_{DD}		5.0		8.0	V
Input high-level voltage	$V_{IH}1$	Pins $\overline{HOLD}$, $\overline{TX}$	$0.7V_{DD}$		12	V
	$V_{IH}2$	Pin $\overline{INIT}$	3.2		V_{DD}	V
	$V_{IH}3$	Pins KI1, KI2, KI3, KI4	$0.6V_{DD}$		V_{DD}	V
Input low-level voltage	$V_{IL}1$	Pins $\overline{HOLD}$, $\overline{TX}$	0		$0.3V_{DD}$	V
	$V_{IL}2$	Pin $\overline{INIT}$	0		1.3	V
	$V_{IL}3$	Pins KI1, KI2, KI3, KI4	0		$0.4V_{DD}$	V
Output voltage	$V_{OUT}1$	Pins SA, SB, SC, SD, SE, SF, SG, D1, D2	0		13	V
	$V_{OUT}2$	Pins $\overline{UL}$, BEEP	0		8	V
Input frequency	$f_{IN}1$	Pin XIN (sine wave, capacitor coupled)	1.0	10.24	15	MHz
	$f_{IN}2$	Pin PIN (sine wave, capacitor coupled)	10		30	MHz
Input amplitude	$V_{IN}1$	Pin XIN (sine wave, capacitor coupled)	0.5		1.5	Vrms
	$V_{IN}2$	Pin PIN (sine wave, capacitor coupled)	0.15		1.5	Vrms
Required oscillating frequency	X'tal	Pins XIN, XOUT (CI ≦ 50 Ω)	5.0	10.24	15	MHz

Electrical Characteristics at under allowable operating conditions

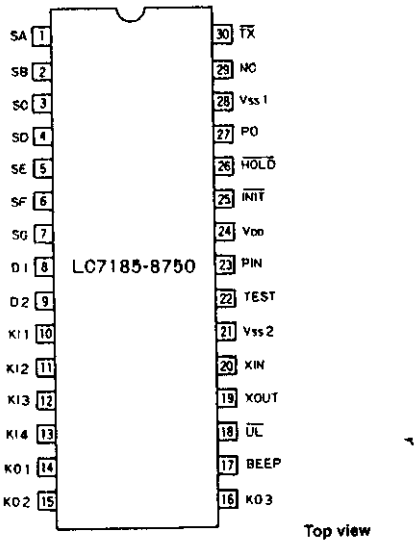
Parameter	Symbol	Conditions	min	typ	max	Unit
Internal feedback resistance	Rf1	Pin XIN		1.0		MΩ
	Rf2	Pin PIN		500		kΩ
Pull-down resistor	RpdN	Pins KI1, KI2, KI3, KI4, TEST	30	50	70	kΩ
Input high-level current	$I_{IH}1$	Pins $\overline{HOLD}$, $\overline{TX}$ V_I = 12 V			5.0	μA
	$I_{IH}2$	Pin $\overline{INIT}$ $V_I = V_{DD}$			5.0	μA
	$I_{IH}3$	Pin XIN $V_I = V_{DD}$			25	μA
	$I_{IH}4$	Pin PIN $V_I = V_{DD}$			50	μA
Input low-level current	$I_{IL}1$	Pins $\overline{HOLD}$, $\overline{TX}$ $V_I = V_{SS}$			5.0	μA
	$I_{IL}2$	Pin $\overline{INIT}$ $V_I = V_{SS}$			5.0	μA
	$I_{IL}3$	Pin XIN $V_I = V_{SS}$			25	μA
	$I_{IL}4$	Pin PIN $V_I = V_{SS}$			50	μA
Output high-level voltage	$V_{OH}1$	Pins KO1, KO2, KO3 I_O = 1 mA	V_{DD}–2.0	V_{DD}–1.0	V_{DD}–0.5	V
	$V_{OH}2$	Pin PD I_O = 0.5 mA	V_{DD}–1.0			V
Output low-level voltage	$V_{OL}1$	Pins KO1, KO2, KO3 I_O = 20 μA	0.6	1.0	1.4	V
	$V_{OL}2$	Pin PD I_O = 0.5 mA			1.0	V
	$V_{OL}3$	Pin BEEP I_O = 2 mA			1.0	V
	$V_{OL}4$	Pins SA, SB, SC, SD, SE, SF, SG I_O = 20 mA			1.0	V
	$V_{OL}5$	Pins D1, D2 I_O = 5 mA			1.0	V
	$V_{OL}6$	Pin $\overline{UL}$ I_O = 10 mA			1.0	V
Output leakage current	$I_{OFF}1$	Pins SA, SB, SC, SD, SE, SF, SG, D1, D2 V_O = 13 V			5.0	μA
	$I_{OFF}2$	Pins $\overline{UL}$, BEEP V_O = 8 V			5.0	μA
High-level tristate leakage current	I_{OFFH}	Pin PD $V_O = V_{DD}$		0.01	10.0	nA
Low-level tristate leakage current	I_{OFFL}	Pin PD $V_O = V_{SS}$		0.01	10.0	nA
Supply current	$I_{DD}1$	Normal mode *1 (PLL operates)		5	10	mA
	$I_{DD}2$	Hold mode V_{DD} = 3.2 V *2 (memory backup) V_{DD} = 8.0 V			5 15	μA μA

*1: $f_{IN}2$ = 20 MHz (PIN)
$V_{IN}2$ = 0.15 Vrms
X'tal = 10.240 MHz
$\overline{TX}$ = $\overline{HOLD}$ = $\overline{INIT}$ = V_{DD}
Other inputs = V_{SS}
Other outputs = open

*2: $\overline{HOLD}$ = V_{SS}
$\overline{TX}$ = $\overline{INIT}$ = V_{DD}
Other inputs = V_{SS}
Other outputs = open

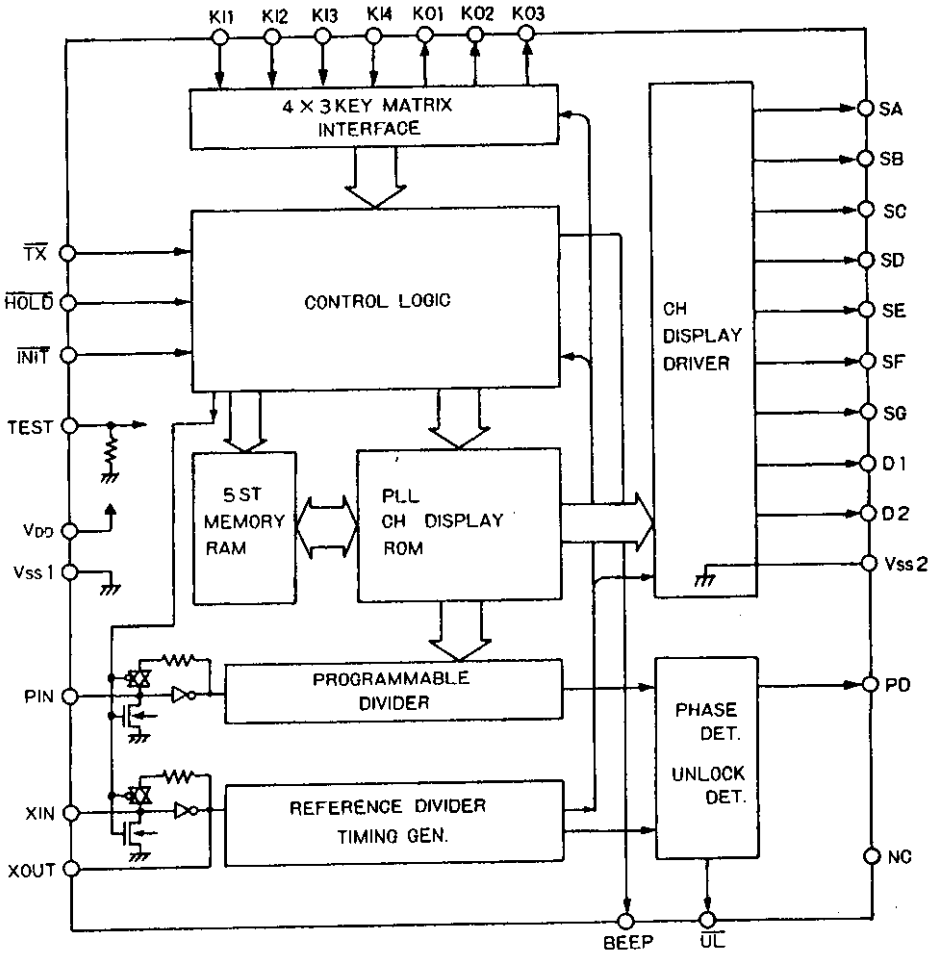
Note: Be careful that the dielectric strength of pins SA, SB, SC, SD, SE, SF, D1, D2, UL, BEEP are weak.

Pin Assignment



Top view

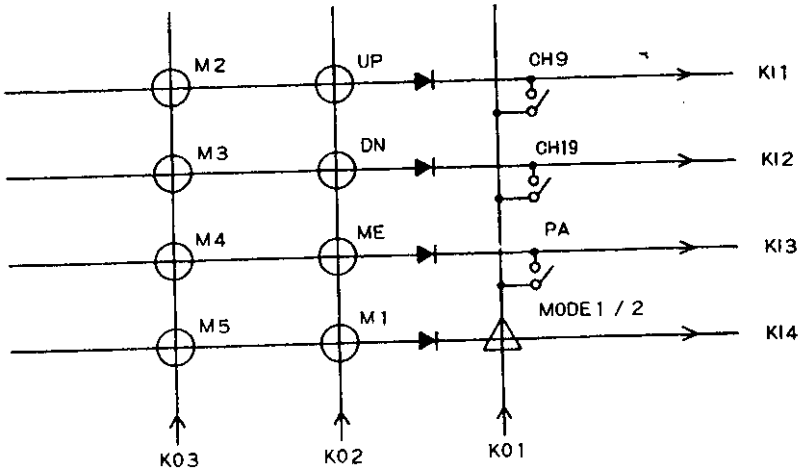
Block Diagram



Pin Descriptions

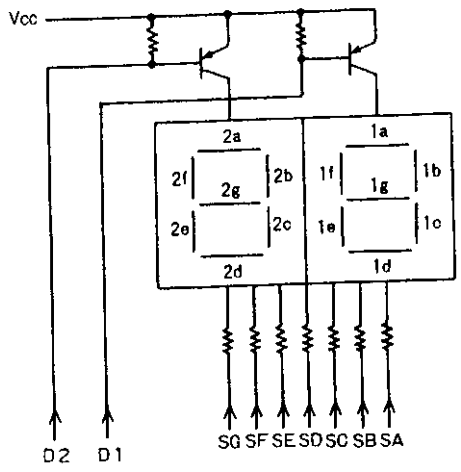
$\overline{TX}$	Transmit/receive select	PD	Charge pump output
$\overline{HOLD}$	Hold mode select	NC	NC pin
$\overline{INIT}$	Initial input	SA to SG	Segment driver (for display)
TEST	Test point (input)	D1, D2	Digit output (for display)
V_{DD}, $V_{SS}1$, $V_{SS}2$	Power supply	KI1 to KI4	Key inputs
PIN	Programmable divider input	KO1 to KO3	Key scan outputs
XIN, XOUT	Crystal oscillator input, output (10.240 MHz)	BEEP	Beep-tone control output
$\overline{UL}$	Unlock detection signal output		

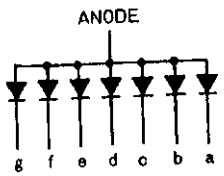
Key Matrix



CH9	Emergency CH9 recall	ME	Station Memory Enable
CH19	Emergency CH19 recall	M1 to M5	Station Memory recall
PA	Public announcement display	UP/DN/ME/M1 to 5	Momentary SW
MODE 1/2	Display Mode	CH9/CH19/PA	Slide SW
UP	CH up/scan	MODE 1/2	Diode
DN	CH down/scan		

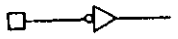
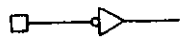
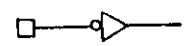
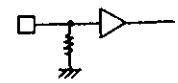
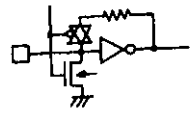
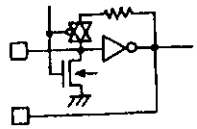
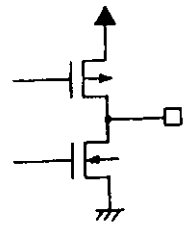
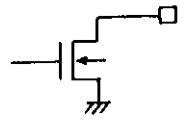
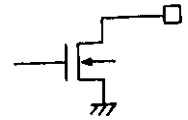
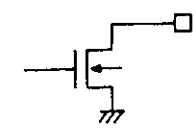
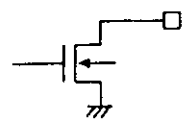
LED Display Configuration (Common anode/7 segment)





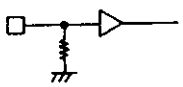
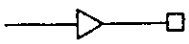
	SG	SF	SE	SD	SC	SB	SA
D1	1g	1f	1e	1d	1c	1b	1a
D2	2g	2f	2e	2d	2c	2b	2a

Pin Description

Pin Name	Pin No.	Type	Description
$\overline{TX}$	30		• Transmit/receive select $\overline{TX}$ = "0"...Transmit, TX = "1"...Receive
$\overline{HOLD}$	26		• Hold mode select $\overline{HOLD}$ = "0"...Hold mode select = "1"...Normal mode select
$\overline{INIT}$	25		• Reset line $\overline{INIT}$ = "0"...Reset
TEST	22		• Test point (input) Tie to ground or leave floating
V_{DD}	24		• Power supply (+) Normal mode: 5.0 to 8.0 V Hold mode: ≧ 3.2 V
$V_{SS}2$	21		• Channel display LED driver ground
PIN	23		• Programmable divider input 150 mVrms min Hold mode: Programmable divider is disabled.
XIN XOUT	20 19		• Crystal oscillator Frequency: 10.24 MHz Hold mode: Oscillator is disabled.
PD	27		• Charge pump output from the phase comparator. If the frequency of fV (the signal obtained by dividing the PIN input by N) is higher than that of fR (the reference signal), or if the phase of fV leads that of fR, positive pulses are output on this pin. If the frequency is lower or the phase lags, negative pulses are output on this pin. If they match, the pin goes to high impedance. • fV > fR OR leading: Positive Pulses • fV < fR OR leading: Negative Pulses • fV = fR and phase muched: High impedance Hold mode: High impedance
$V_{SS}1$	28		• PLL circuit and controller ground
NC	29		• No-connection
$\overline{UL}$	18		• Unlock detected output Fixed to low level when unlocked, when changing channels, in PA mode, or in hold mode. Open: Locked
BEEP	17		• Beep-tone control output During station memory operation During I/O on emergency channel When changing channels During reset During hold mode recovery Fixed to low level in hold mode Transistor: Off (50 ms cycle) → Open
SA to SG	1 to 7		• Segment drivers for the display (Common anode/7 segments)
D1 D2	8 9		• Digit output (150 Hz) for the display (common anode/7 segments) Hold mode: Transistor goes off.

Continued on next page.

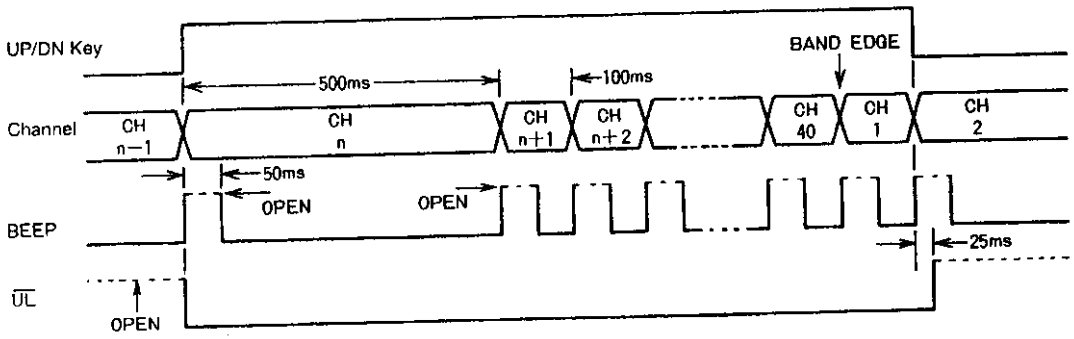
Continued from preceding page.

Pin Name	Pin No.	Type	Description
KI1 to KI4	10 to 13		• Key inputs Input from the key matrix
KO1 to KO3	14 to 16		• Key scan output (75 Hz) Output to the key matrix Hold mode: Low (scanning stops)

Operation

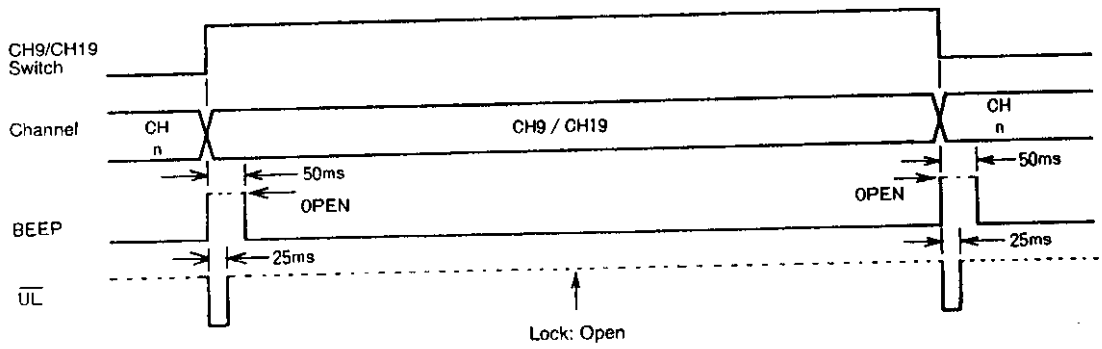
(1) Channel Selection (up/down)

1. Manual scanning (up/down)
   Pressing the UP key increments by one channel and pressing the DN key decrements by channel.
   When scanning reaches the end of the band, it automatically wraps around to the beginning.
2. Auto scanning (up/down)
   Holding the UP (or DN) key down for 500 ms or longer starts auto scanning. For both up and down scanning, each channel takes 100 ms to scan.
3. The unlock detected line ($\overline{UL}$) is asserted (low) when the UP (or DN) key is pressed and deactivated 25 ms after the key is released.
4. The beep-tone control line (BEEP) is asserted (open) for 50 ms after each new channel is selected.



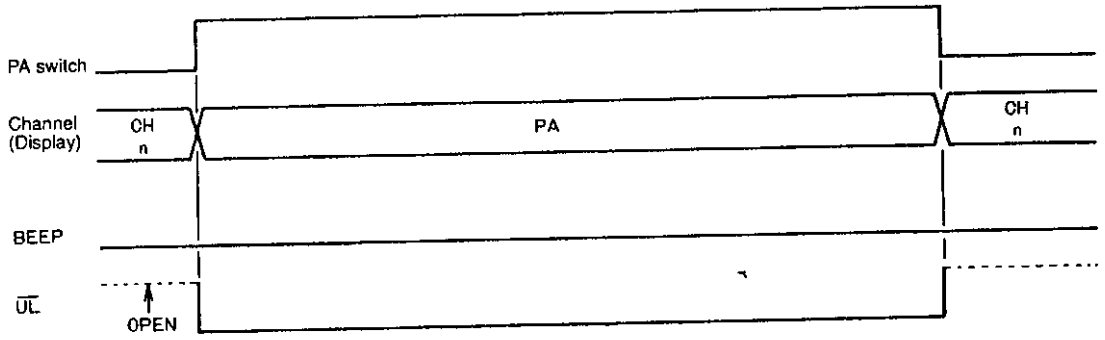
(2) Selecting an Emergency Channel (CH9/CH19)

1. If the CH9 or CH19 switch is turned on, the LC7185 stores the value of the previous channel and asserts the beep-tone control line for 50 ms.
2. While the CH9 or CH19 switch is turned on, the LC7185 disables all keys except $\overline{TX}$ and PA (UP/DN, ME, and M1 to M5 switches).
3. Even if the CH9 or CH19 switch is turned off while transmitting using the CH9 or CH19 switch, keep the emergency channel open until the LC7185 is in the receive mode.
4. After the CH9 or CH19 switch is turned back off, the beep-tone control line is asserted for 50 ms and the LC7185 reopens the previous channel.
5. Note the CH9 has a higher priority over CH19. As a result, if both switches are turned on, CH9 will be opened.
6. The $\overline{UL}$ line is asserted for 25 ms after the CH9 or CH19 switch is turned off or on.
7. Causes either "9" or "19" to blink on the display.



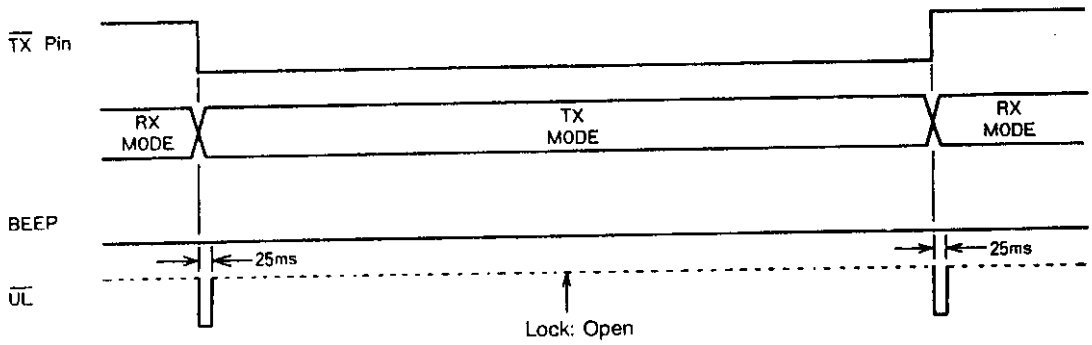
(3) Public Announcement (PA) Mode

1. When the PA switch is turned on, the LC7185 stores the value of the previous channel and enters the PA mode.
2. While the PA switch is turned on, the LC7185 disables all keys ($\overline{TX}$, CH9/CH19, UP/DN, ME, M1 to M5)
3. "PA" is displayed on the channel display.
4. When the PA switch is turned back off, the LC7185 enters the CB mode and reopens the previous channel.
5. The $\overline{UL}$ line is asserted while the PA switch is turned on.



(4) Transmit/Receive Selection

1. When the $\overline{TX}$ line is asserted, the LC7185 enters TX mode.
2. If the PA switch is turned on while the LC7185 is in TX mode, the device enters PA mode. However, if any other switch (other than the PA switch) or key (UP/DN, ME, M1 through M5, CH9, CH19) is pressed while the LC7185 is in TX mode, that switch or key has no effect.
3. The unlock detected signal is output each time the device switches between transmitting and receiving.



(5) Channel Preset/Recall Facility

1. The LC7185 allows up to 5 channels to be preset (assigned to M1 to M5).
   - After a reset (when the power is turned on, etc.), M1 to M5 are assigned to CH33.
2. Recalling preset channels
   - A preset channel is recalled by pressing one of the preset memory keys (M1 to M5) to which the channel was previously assigned.
   - There are two different display modes as shown below.

   Mode 1 (without diode)
   Each time a key is pressed (M1 to M5), the new channel is displayed.
   Example: Display 21 → 15
   key M1

   Mode 2 (with diode)
   Each time a key is pressed (M1 to M5), a key mnemonic ("P1" to "P5") is displayed for 400 ms, then the new channel is displayed.
   Example: Display 21 → P1 → 15
   400 ms
   Key M1

3. Presetting channels
   - First select the channel to be preset, then hold down the ME key and press the preset memory key (M1 to M5) to which you would like to assign the current channel.
     In the following cases, a channel will not be preset:
     - M1 to M5 is pressed and in the memory preset mode.
     - Emergency channels CH9 or CH19 are currently selected.
     - The $\overline{TX}$ line is asserted.
     - The PA switch is turned on (PA mode).
     - The $\overline{HOLD}$ line is asserted (hold mode).

   Even if the above key operations are not performed, the preset mode will be canceled automatically after 9 seconds.

   - There are two different display modes as shown below.

     Mode 1 (without diode)

     The current channel is displayed throughout the preset process.

     Example: Display 15 ——→ 15
     Key [ME] [M1]

     Mode 2 (with diode)

     When the ME key is held down, "PE" is flashed on the display, indicating that presetting is possible. Once a preset memory key (M1 to M5) is pressed, the key mnemonic ("P1" to "P5") is displayed for 400 ms before the current channel is redisplayed.

     Example: Display 15 → PE → P1 → 15
     400 ms
     Key [ME] [M1]

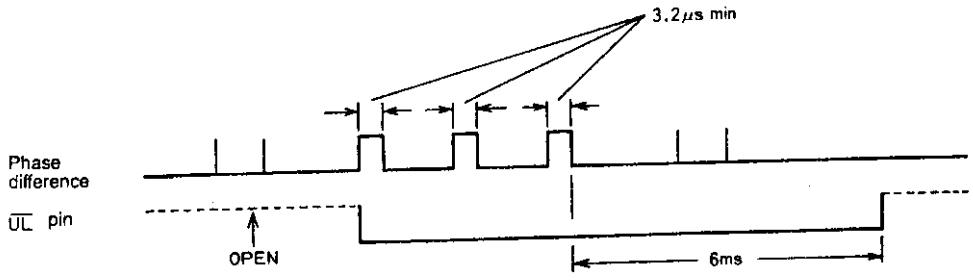
   - Note that if two or more keys are pressed at the same time, priority is assigned as follows:
     M1 > M2 > M3 > M4 > M5

(6) Beep-tone Control Output (BEEP pin)

After each of the following events, the BEEP line is asserted for 50 ms:
- A reset, such as a battery replacement ($\overline{INIT}$ = 0)
- Any key press associated with the channel memory
- Any emergency channel switch activation
- A new channel is selected
- Leaving hold mode

(7) Unlock Detected Output ($\overline{UL}$ pin)

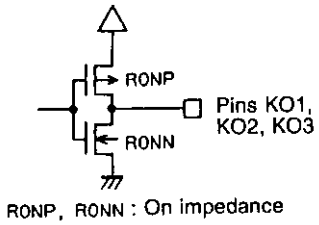
In the following cases, the $\overline{UL}$ line is asserted.
- When the phase difference between the programmable and reference divider outputs exceeds 3.2 µs, the $\overline{UL}$ line is held low for 6 ms after the last out-of-range phase sample is detected, as shown below.



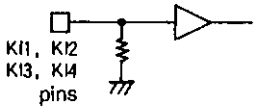
- After a new transmit/receive or channel selection, the $\overline{UL}$ line is asserted for 25 ms.
- While the PA switch is turned on, the $\overline{UL}$ line is asserted during PA mode.
- The $\overline{UL}$ pin is open while the device is in the PLL LOCK state (when the phase difference is < 3.2 µs).

(8) Key Matrix

It is normal to put diodes in series with the key scanning lines to avoid creating a short with the output lines. But KO1, KO2 and KO3 lines (key scan signal output) do not need diodes.



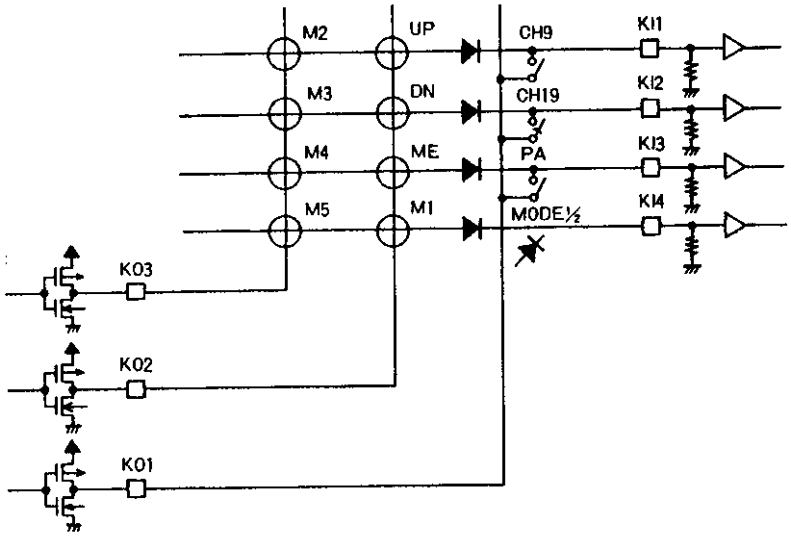
RONP, RONN : On impedance



RpdN : Pull-down resistor

unit : kΩ

Item	min	typ	max
RONP	0.5	1.0	2.0
RONN	30	50	70
RpdN	30	50	70



Explanation Regarding Power On and Hold Mode

(1) Operation in hold mode

When in hold mode ($\overline{HOLD}$ = 0), the LC7185-8750 does not accept any operation other than the $\overline{INIT}$ pin being asserted (reset). The primary function of hold mode is to maintain the contents of station memory.

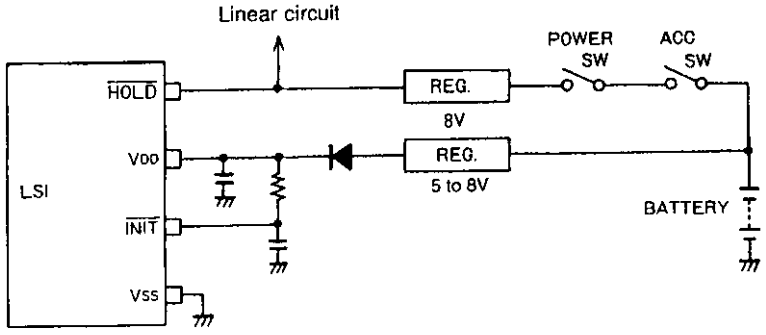
- In hold mode, the programmable divider, crystal oscillator and reference divider are all stopped. The PD pin (charge pump output) goes to high impedance. The $\overline{UL}$ pin goes to V_{SS}.
- The channel display pins D1 and D2 go to high impedance.
- The BEEP pin goes to V_{SS}.
- The key scan signal outputs (KO1 to KO3) go to V_{SS}.

When the LC7185-8750 leaves hold mode, the previously selected channel is reopened.

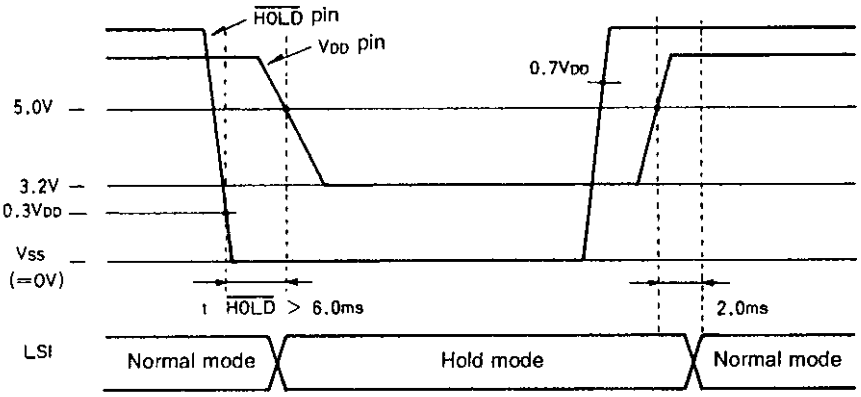
(2) Initial state settings

The LC7185-8750 can be reset to its initial state settings (reset) after the battery has been replaced, etc., by setting $\overline{INIT}$ = 0. The initial state that is established by an initial reset is as follows:

- When the V_{DD} pin turned on, CH9 or CH33 is selected.
- When the V_{DD} pin operate voltage already, CH9 is selected.
- All of station memory is set to CH33.



(3) Timing Requirements for Hold Mode

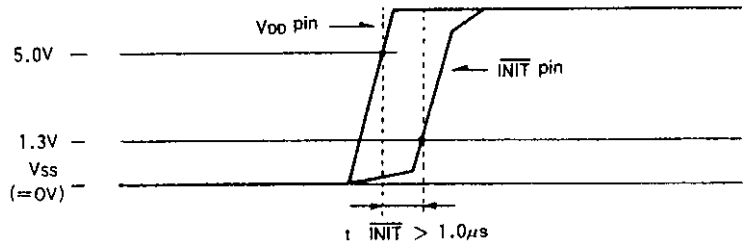


V_{DD} must remain at 5.0 V or higher (crystal oscillator requirement) for 6.0 ms (t $\overline{HOLD}$) after the $\overline{HOLD}$ line is asserted ($\overline{HOLD}$ = 0 (< 0.3 V_{DD}). After this, V_{DD} may go as low as 3.2 V.
There are no constraints on timing for the $\overline{HOLD}$ and V_{DD} pins when the chip is leaving hold mode.
The signal can be activated in one of two orders.

If $\overline{HOLD}$ is already deactivated (> 0.7 V_{DD}), the LC7185-8750 leaves hold mode within 2.0 ms after V_{DD} rises to >5.0 V.
If V_{DD} is > 5.0 V, the LC7185-8750 enters normal mode within 2.0 ms after $\overline{HOLD}$ is deactivated.

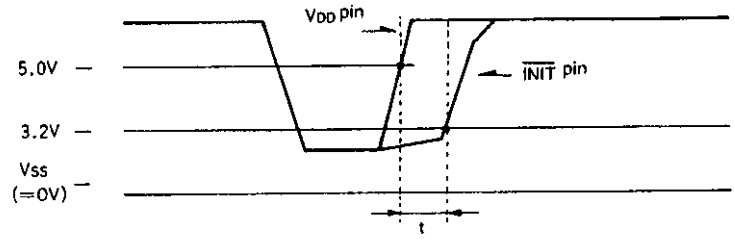
(4) Reset Timing

1. Reset timing (e.g. battery replacement)



Note: t$\overline{INIT}$ should be greater than 1.0 μs.

2. Reset caused by a sudden voltage (V_{DD}) drop



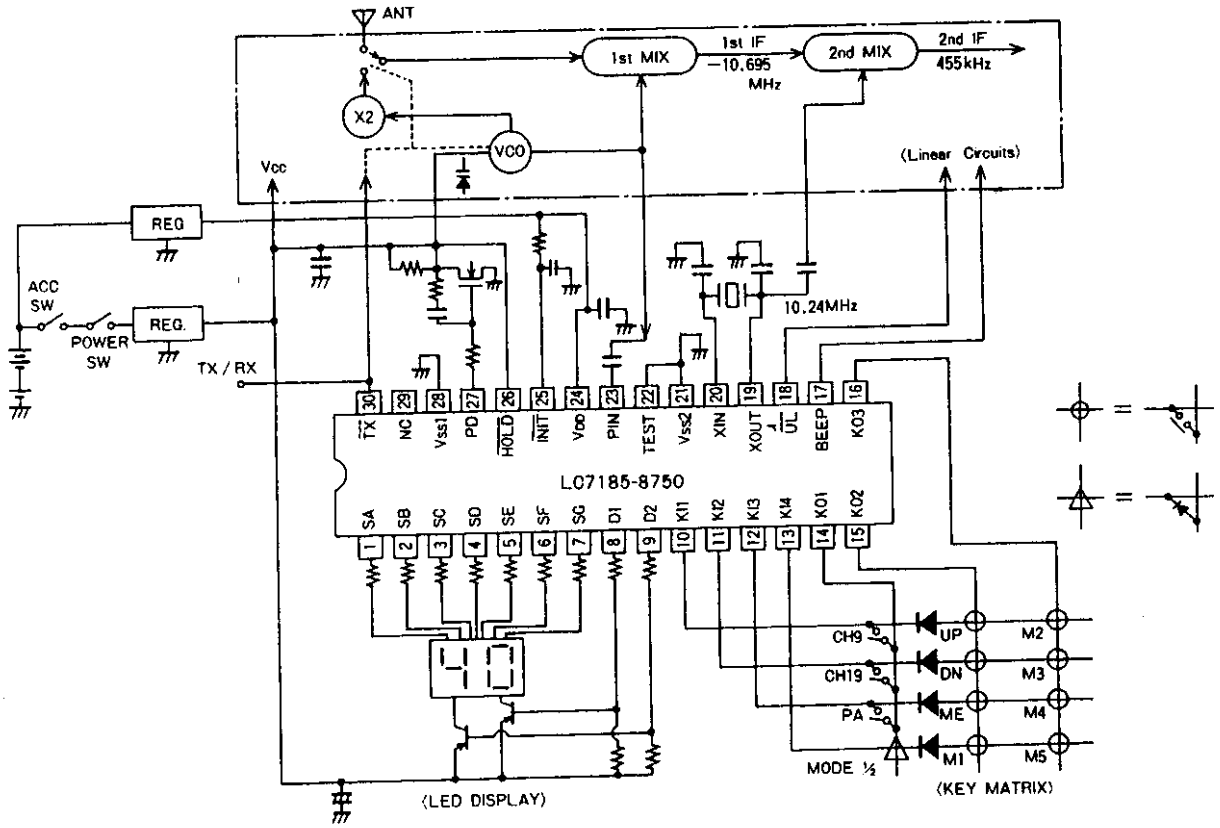
If V_{DD} drops momentarily down to less than 3.2 V and rises up to more than 5.0 V t > t$\overline{INIT}$ (t > 1.0 μs), a reset may be generated.

Frequency Table (U.S.A.: LC7185-8750)

CHANNEL	FREQUENCY (MHz)	RX ($\overline{TX}$ = 1)		TX ($\overline{TX}$ = 0)	
		N	Fvco	N	Fvco
1	26.965	6508	16.27	5393	13.4825
2	26.975	6512	16.28	5395	13.4875
3	26.985	6516	16.29	5397	13.4925
4	27.005	6524	16.31	5401	13.5025
5	27.015	6528	16.32	5403	13.5075
6	27.025	6532	16.33	5405	13.5125
7	27.035	6536	16.34	5407	13.5175
8	27.055	6544	16.36	5411	13.5275
9	27.065	6548	16.37	5413	13.5325
10	27.075	6552	16.38	5415	13.5375
11	27.085	6556	16.39	5417	13.5425
12	27.105	6564	16.41	5421	13.5525
13	27.115	6568	16.42	5423	13.5575
14	27.125	6572	16.43	5425	13.5625
15	27.135	6576	16.44	5427	13.5675
16	27.155	6584	16.46	5431	13.5775
17	27.165	6588	16.47	5433	13.5825
18	27.175	6592	16.48	5435	13.5875
19	27.185	6596	16.49	5437	13.5925
20	27.205	6604	16.51	5441	13.6025
21	27.215	6608	16.52	5443	13.6075
22	27.225	6612	16.53	5445	13.6125
23	27.255	6624	16.56	5451	13.6275
24	27.235	6616	16.54	5447	13.6175
25	27.245	6620	16.55	5449	13.6225
26	27.265	6628	16.57	5453	13.6325
27	27.275	6632	16.58	5455	13.6375
28	27.285	6636	16.59	5457	13.6425
29	27.295	6640	16.60	5459	13.6475
30	27.305	6644	16.61	5461	13.6525
31	27.315	6648	16.62	5463	13.6575
32	27.325	6652	16.63	5465	13.6625
33	27.335	6656	16.64	5467	13.6675
34	27.345	6660	16.65	5469	13.6725
35	27.355	6664	16.66	5471	13.6775
36	27.365	6668	16.67	5473	13.6825
37	27.375	6672	16.68	5475	13.6875
38	27.385	6676	16.69	5477	13.6925
39	27.395	6680	16.70	5479	13.6975
40	27.405	6684	16.71	5481	13.7025

V_{CO} (TX) = RF + 2
V_{CO} (RX) = RF – 10.695 MHz (IF)
CH1: V_{CO} (TX) = 26.965 + 2 = 13.4825
V_{CO} (RX) = 26.965 – 10.965 = 16.27

Sample Application Circuit



APPENDIX 10

FINAL RF AMPLIFIER DATA SHEETS

FOUR (4) PAGES OF KTC2078 DATA SHEETS FOLLOW THIS SHEET

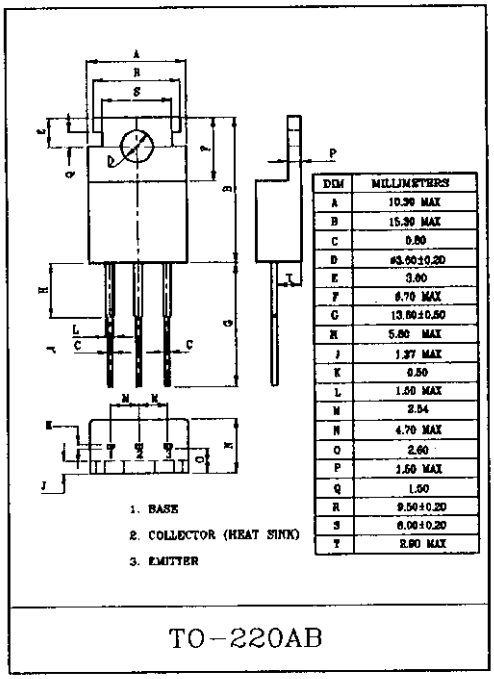
KEC
KOREA ELECTRONICS CO.,LTD.

SEMICONDUCTOR
TECHNICAL DATA

KTC2078
TRIPLE DIFFUSED NPN TRANSISTOR

CB TRANSCEIVER TX FINAL AMPLIFIER APPLICATION.
HF TRANSCEIVER APPLICATION.

FEATURES
- Recommended for Output Stage Application of AM 4W Transmitter.
- High Power Gain.
- Wide Area of Safe Operation.



DIM	MILLIMETERS
A	10.30 MAX
B	15.30 MAX
C	0.80
D	3.60±0.20
E	3.60
F	6.70 MAX
G	13.50±0.50
H	5.80 MAX
J	1.37 MAX
K	0.50
L	1.50 MAX
M	2.54
N	4.70 MAX
O	2.60
P	1.50 MAX
Q	1.50
R	2.50±0.20
S	6.00±0.20
T	2.90 MAX

TO-220AB

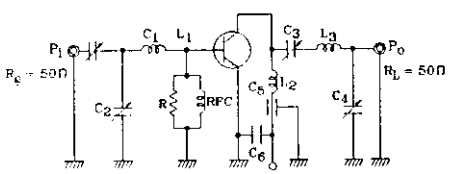
MAXIMUM RATINGS(Ta=25℃)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Collector-Base Voltage	V_{CBO}	80	V
Collector-Emitter Voltage (R_{BE}=50Ω)	V_{CER}	80	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current	I_C	4	A
Emitter Current	I_E	-4	A
Collector Power Dissipation (Tc=25℃)	P_C	10	W
Junction Temperature	T_j	150	℃
Storage Temperature Range	T_{stg}	-55~150	℃

ELECTRICAL CHARACTERISTICS (Ta=25℃)

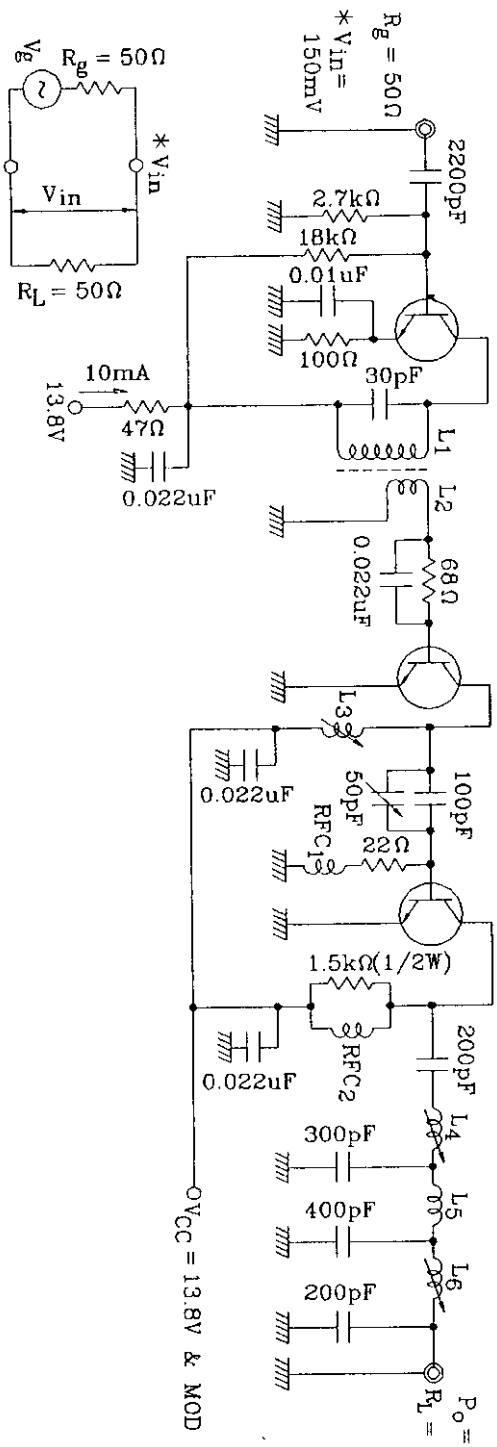
CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Collector Cut-off Current		I_{CBO}	V_{CB}=30V, I_E=0	-	-	10	μA
Breakdown Voltage	Collector-Emitter	$V_{(BR)CER}$	I_C=10mA, R_{BE}=50Ω	80	-	-	V
	Emitter-Base	$V_{(BR)EBO}$	I_E=1.0mA, I_C=0	4	-	-	V
DC Current Gain		h_{FE}	V_{CE}=5V, I_C=0.5A	100	-	200	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_C=3A, I_B=0.3A	-	-	1.5	V
Transition Frequency		f_T	V_{CE}=5V, I_C=500mA	100	-	-	MHz
Collector Output Capacitance		C_{ob}	V_{CB}=10V, I_E=0, f=1MHz	-	40	-	pF
Output Power (Fig.1)		P_o	V_{CC}=12V, P_i=0.3W, f=27MHz	4	-	-	W

Fig.1 P_o TEST CIRCUIT



C_1:~100pF, C_2,C_3:~150pF, C_4:~300pF, C_5:1000pF
C_6:0.01μF, R:250Ω
L_1:0.8mm φ UEW,7T,8mm I.D L_2:0.8mm φ UEW,5T,8mm I.D
L_3:0.8mm φ UEW,10T,8mm I.D RFC:0.35mm φ UEW,17T,5mm I.D

Fig.2 27MHz 4W OUTPUT AM TRANSCEIVER CIRCUIT



L_1 : 4mmø BOBBIN WITH FERRITE CORE, 0.08mmø UEW, 8 TURNS

L_2 : 4mmø BOBBIN WITH FERRITE CORE, 0.08mmø UEW, 2 TURNS

L_3, L_6 : 6.5mmø BOBBIN WITH FERRITE CORE, 0.6mmø Sn PLATED COPPER WIRE $6\frac{1}{2}$ TURNS

L_4 : 6.5mmø BOBBIN WITH FERRITE CORE, 0.6mmø Sn PLATED COPPER WIRE $8\frac{1}{2}$ TURNS

L_5 : 0.6mmø Sn PLATED COPPER WIRE, 6.5mm I.D, $8\frac{1}{2}$ TURNS

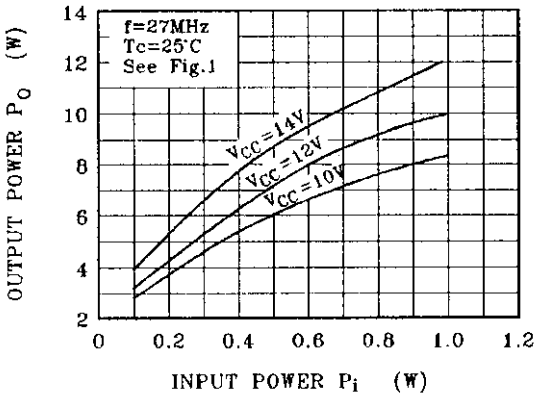
RFC_1 : 4.7uH,7BA-480k (TOKO)

RFC_2 : 0.2mmø UEW, 30 TURNS

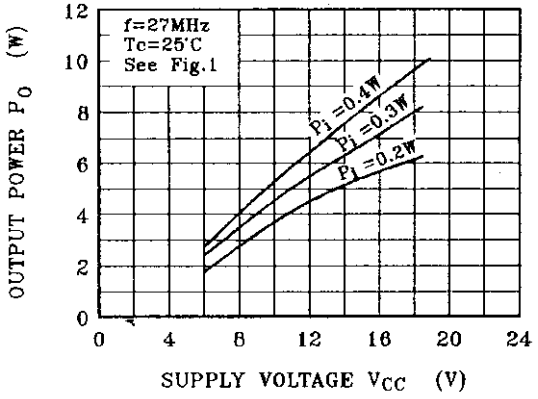
RESISTOR : 1/4W CARBON

CAPACITOR : CERAMIC

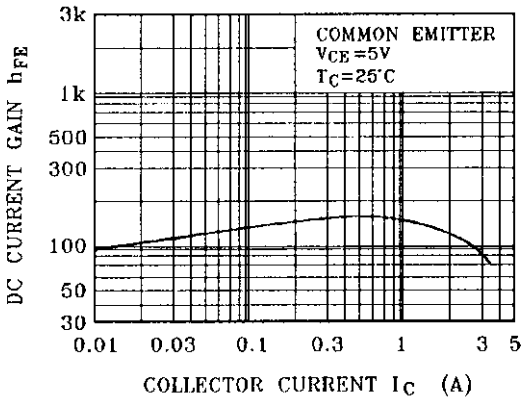
P_O – P_i



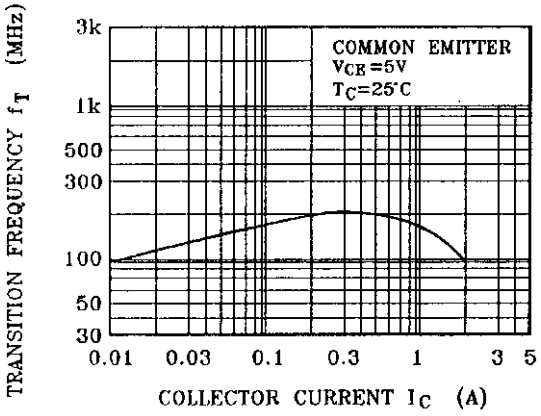
P_O – V_{CC}



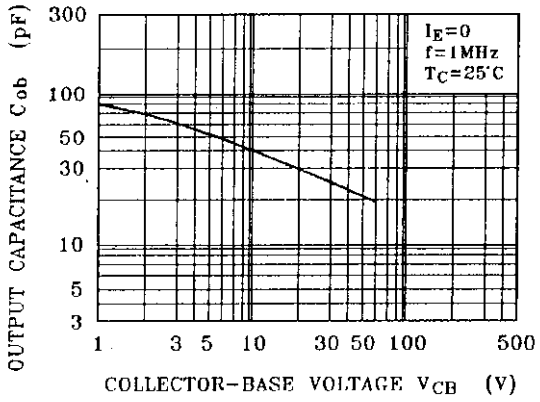
h_{FE} – I_C



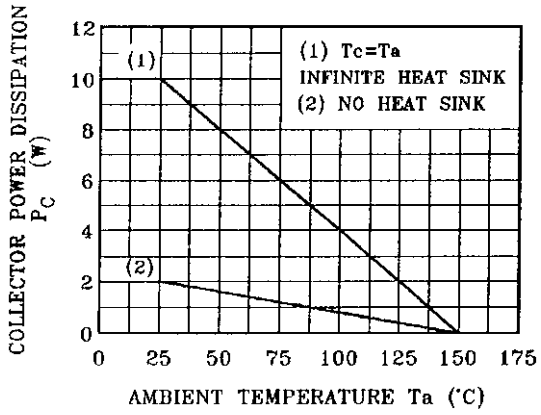
f_T – I_C



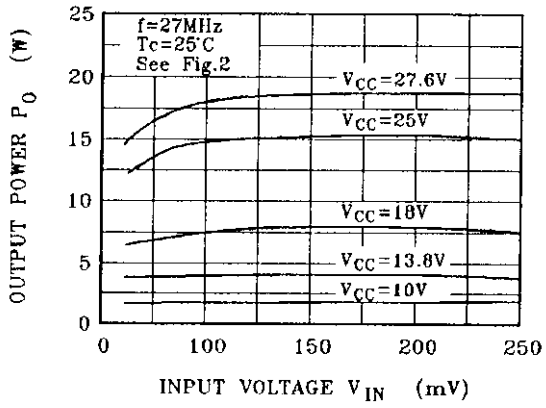
C_{ob} – V_{CB}



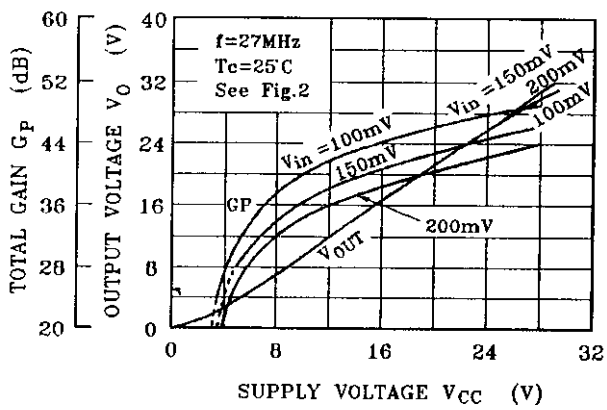
P_C – Ta



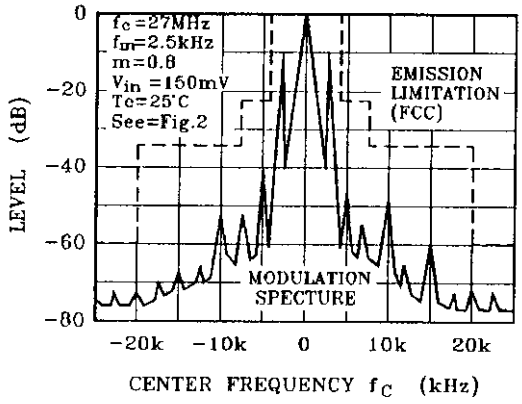
P_O – V_{IN}



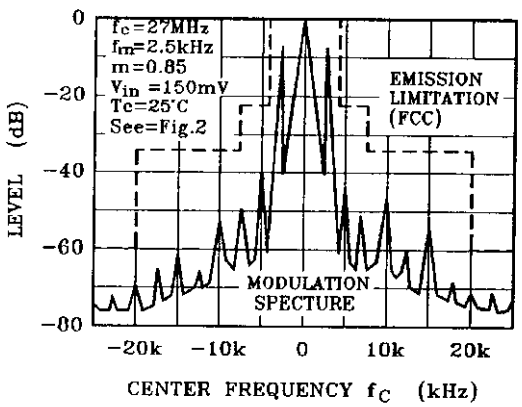
V_O, G_P – V_{CC}



80% MODULATION SPECTRUM
EMISSION LIMITATION (FCC)



85% MODULATION SPECTRUM
EMISSION LIMITATION (FCC)



A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the TRC-239 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The TRC-239 is a double sideband amplitude modulated transmitter/receiver combination intended for portable operation in the citizens radio service. The transmitter has 40-channel capability in the 26.965 - 27.405 MHz band utilizing phase locked loop (PLL) technology.

B. GENERAL INFORMATION REQUIRED FOR TYPE CERTIFICATION (Paragraph 2.983 of the Rules)

1. Name of applicant: Radio Shack, a Div. of Tandy Corp.

2. Identification of equipment: FCC ID: AAO2101628

   a. The equipment identification label is shown in Appendix 1.

   b. Photographs of the equipment are included in Appendix 2.

3. Quantity production is planned.

4. Technical description:

   a. 6k00A3E emission
   b. Frequency range: 26.965 - 27.405 MHz
   c. Operating power of transmitter is fixed at the factory at less than 4 watts and can be reduced 6 dB.
   d. Maximum power rating under 95.635(c) of the Rules is 4 watts.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 13.4 V
      Collector current: 0.56 mA @ 13.8 Vdc input.

   f. Function of each active semiconductor device: See Appendix 3.
   g. Complete circuit diagram is included as Appendix 4.
   h. A draft instruction book is submitted as Appendix 5.
   i. The transmitter tune-up procedure is included in Appendix 6.
   j. A description of circuits for stabilizing frequency is included in Appendix 7.
   k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 8.
   l. Not applicable.

B. GENERAL INFORMATION...(Continued)

5. Data for 2.985 through 2.997 follow this section.

6. RF Power Output (Paragraph 2.985(a),(b)(1) of the Rules)

RF power output in the AM mode was measured with a Bird 4421 RF power meter and a Narda 765-20 50 ohm dummy load. (The transmitter was tuned by the factory according to the procedure of Exhibit 4.) Power was measured with a supply voltage of 13.8 volts, and indicated:

Channel	Power, W	
	High	Low
1	4.0	0.8
21	4.0	0.8
40	4.0	0.8

C. MODULATION CHARACTERISTICS

1. AF Frequency Response

A curve showing frequency response of the transmitter is shown in Figure 1. Reference level was taken as a 1 kHz tone with 50% modulation, as measured on a Data Tech 209 modulation meter, using Audio Precision System One digital voltmeter and tracking generator.

2. Modulation Limiting

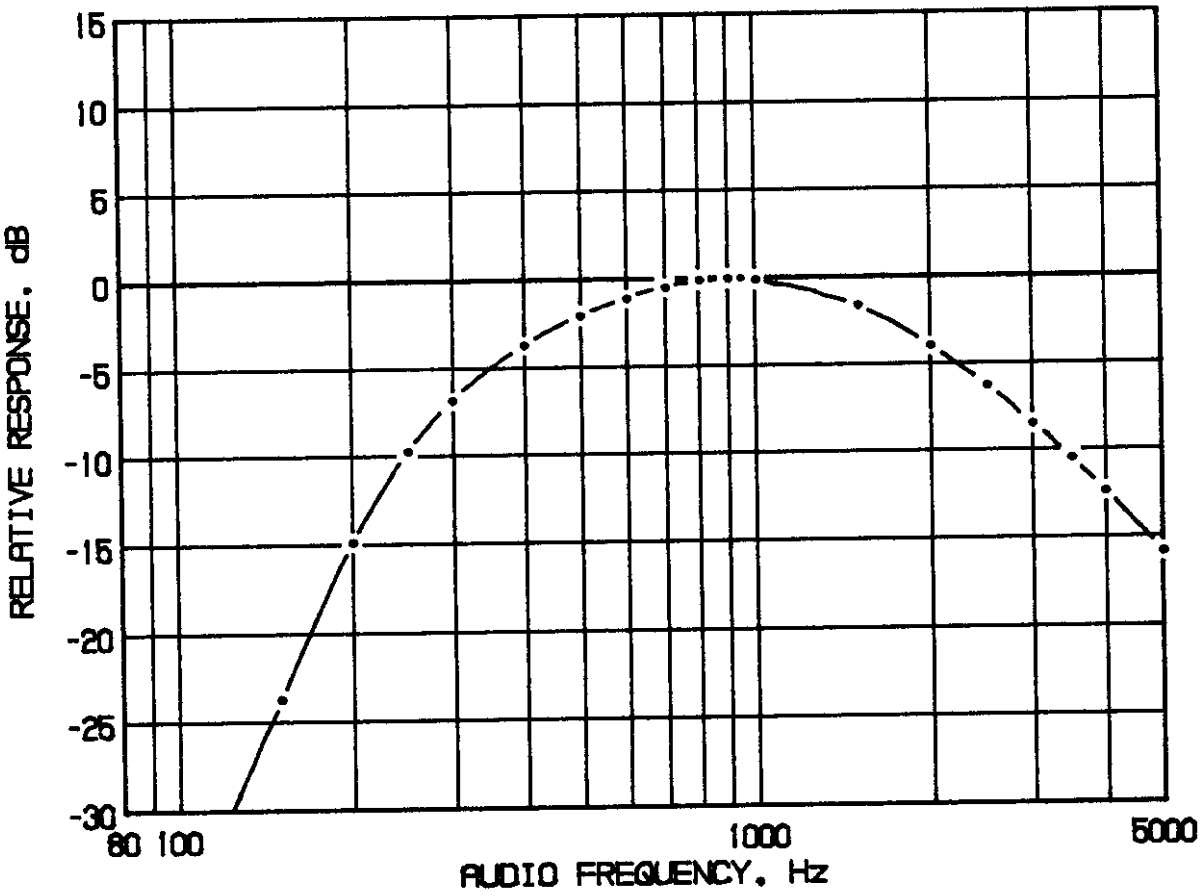
Curves of AM modulation limiting for both positive and negative peaks are shown in Figures 2a and 2b, respectively. Characteristics at 300, 910, and 2500 Hz are shown using a Data Tech 209 modulation meter. Signal level was established with a Audio Precision System One digital voltmeter. The curves show compliance with Paragraph 95.633(d) of the Rules.

3. Modulation Limiter Attack Time

Modulation limiter attack time was measured by applying to the microphone input terminals a pulsed tone at 2500 Hz, 16 dB above the level required for 50% modulation at the frequency of maximum response, 910 Hz. The spectrum analyzer was tuned to upper and lower fourth-order sidebands in the time domain. Horizontal sweep of the analyzer was triggered in synchronism with the tone turn-on. Sweep speed was 100 milliseconds per division. Plots are included as Figures 3a and 3b. Any transients observed in excess of 33 dB attenuation as referenced to the carrier were less than 20 ms in duration.

FIGURE 1

TRANSMITTER FREQUENCY RESPONSE

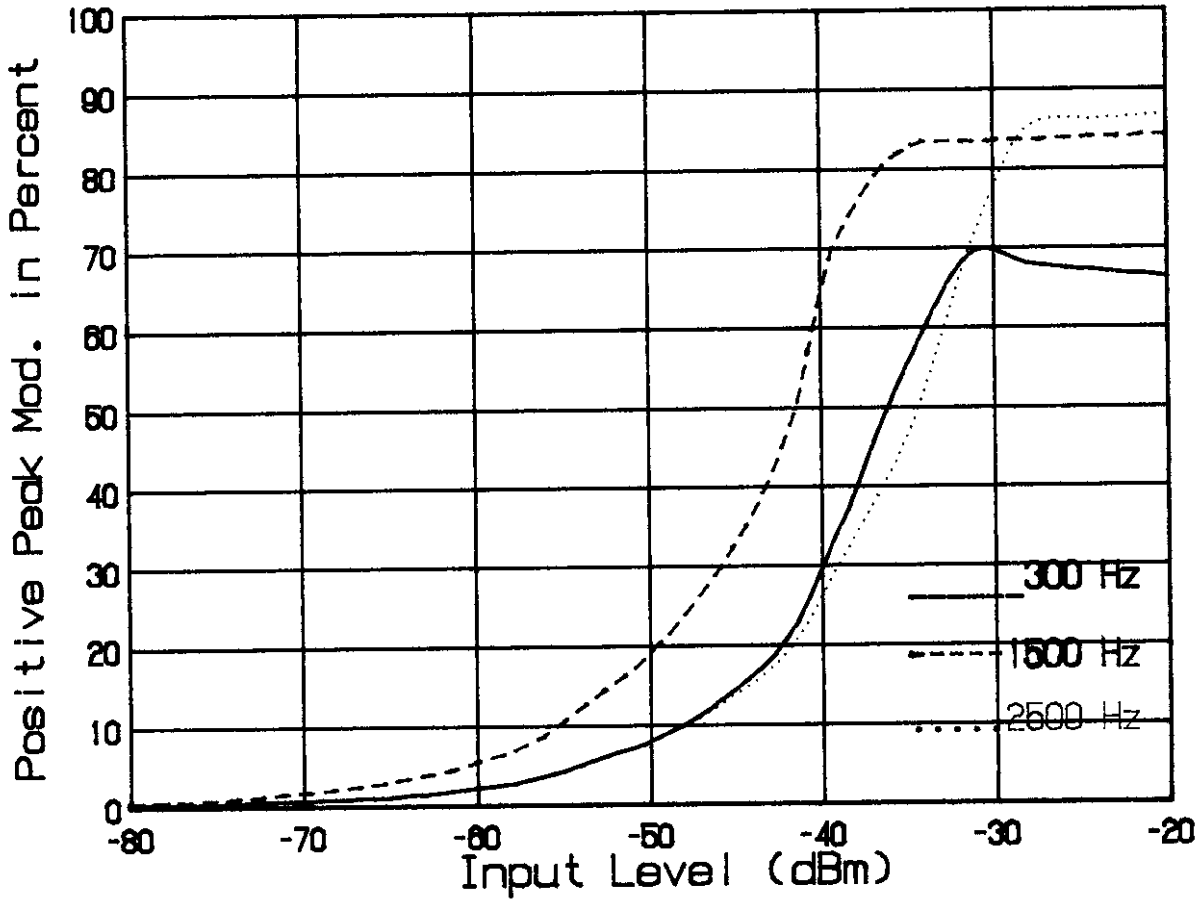


TRANSMITTER FREQUENCY RESPONSE
FCC ID: AAO2101628

FIGURE 1

FIGURE 2a

AM MODULATION LIMITING - POSITIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

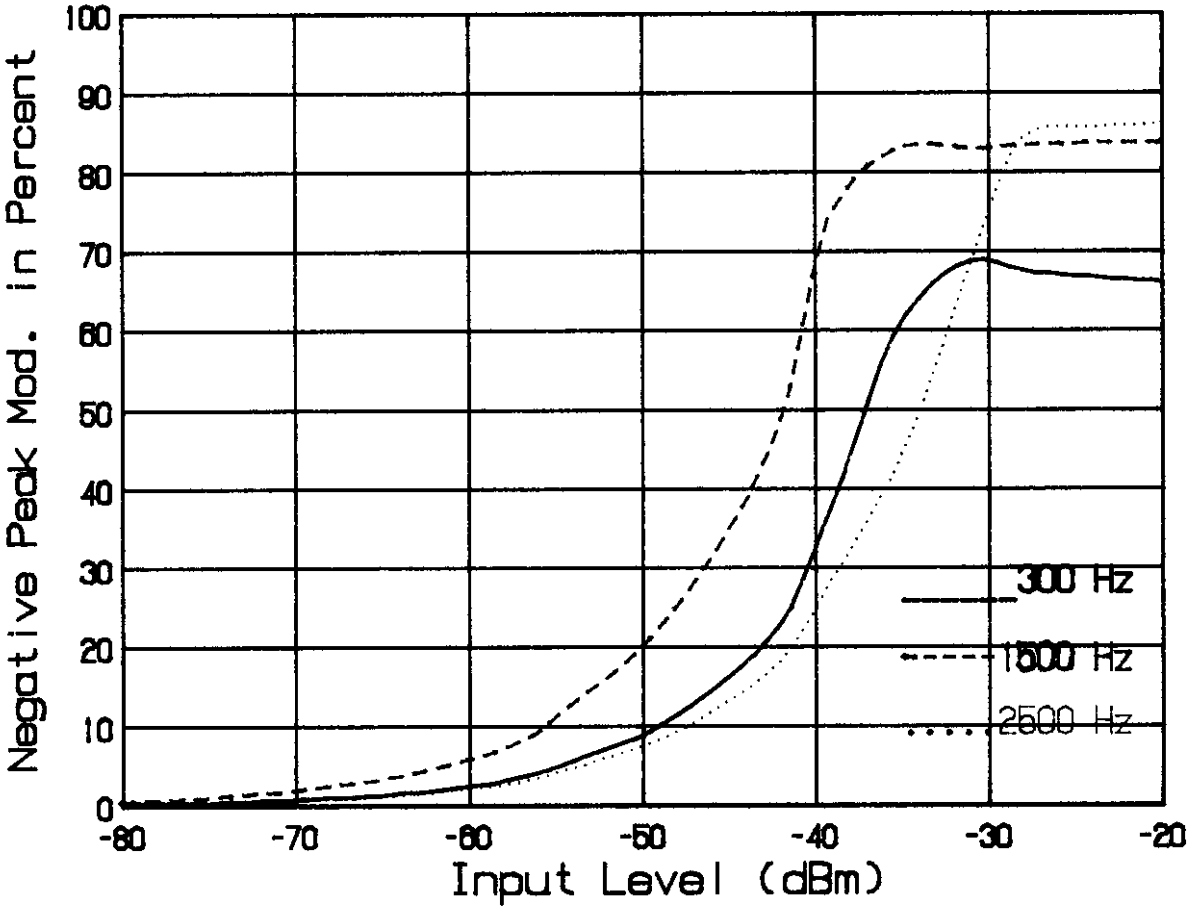
Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 910 Hz, and 2500 Hz tones.

MODULATION LIMITING POSITIVE PEAKS
FCC ID: AAO2101628

FIGURE 2a

FIGURE 2b

AM MODULATION LIMITING - NEGATIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 910 Hz, and 2500 Hz tones.

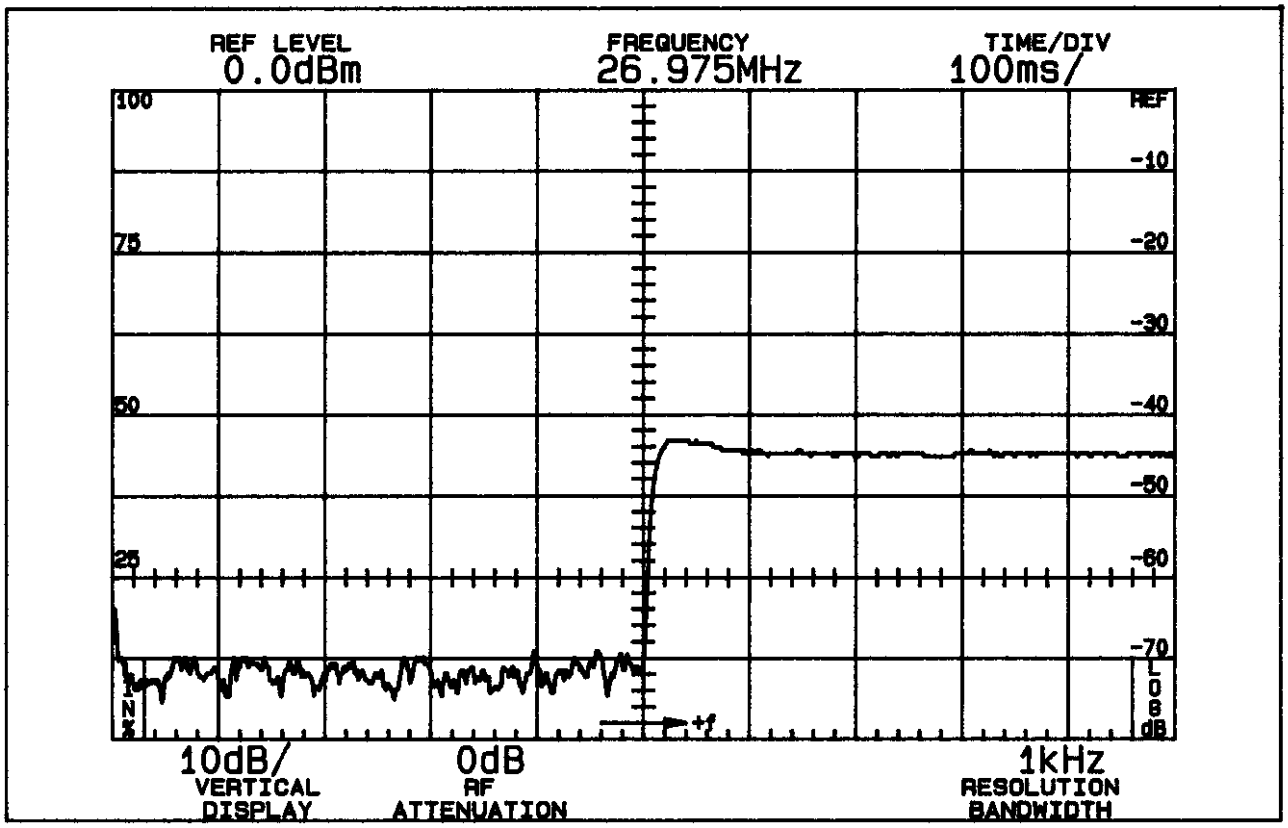
MODULATION LIMITING NEGATIVE PEAKS
FCC ID: AAO2101628

FIGURE 2b

A: \TRACEBOH.CBM

FIGURE 3a

MODULATION LIMITER ATTACK TIME



Measurement Conditions: 16 dB over 50% modulation level at 910 Hz with 2500 Hz tone, upper fourth order sideband; horizontal scale 100 ms/div.

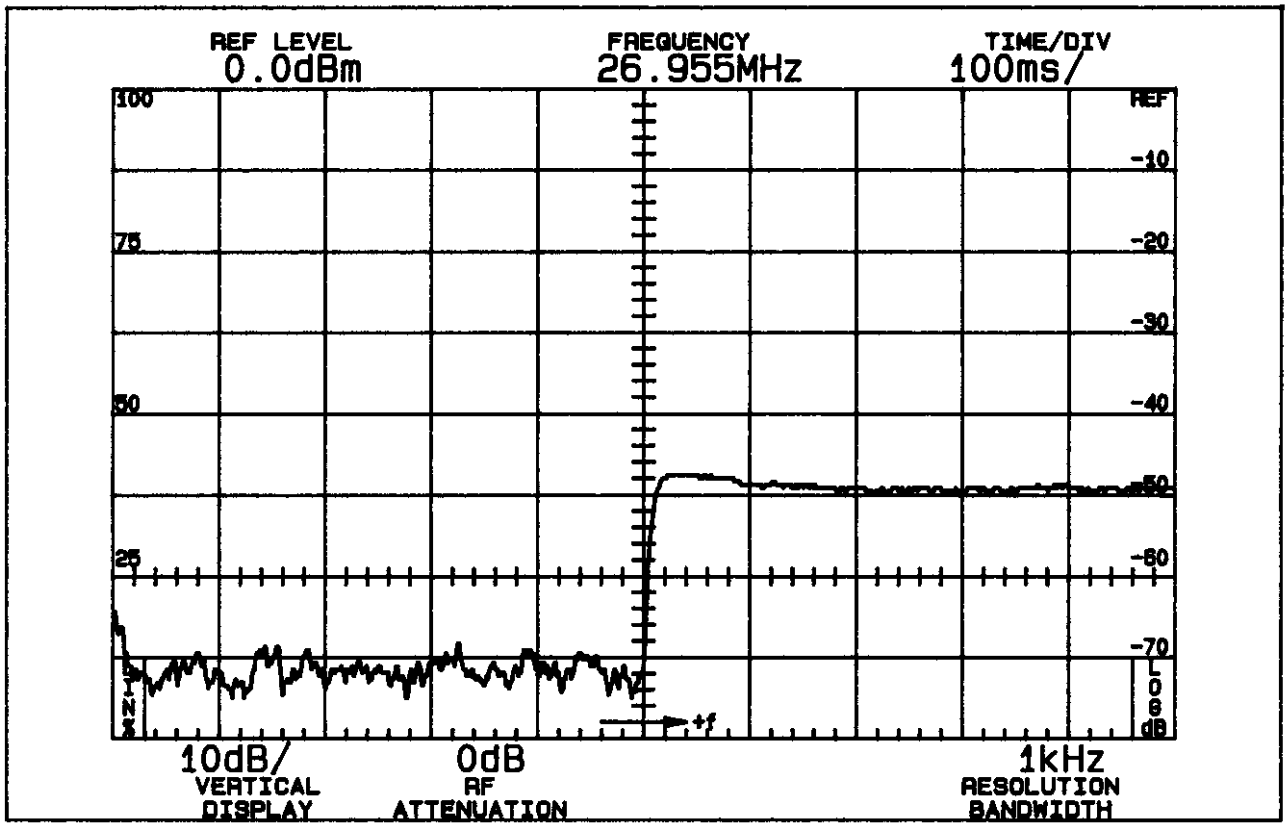
UPPER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: AAO2101628

FIGURE 3a

A: \TROSSCL.CSV

FIGURE 3b

MODULATION LIMITER ATTACK TIME



Measurement Conditions: 16 dB over 50% modulation level at 910 Hz with 2500 Hz tone, lower fourth order sideband; horizontal scale 100 ms/div.

LOWER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: AAO2101628

FIGURE 3b

C. MODULATION CHARACTERISTICS (Continued)

4. Occupied Bandwidth - AM
(Paragraph 2.989(c) of the Rules)

Figures 4a and 4b are plots of the sideband envelope of the transmitter taken from a Tektronix 494P spectrum analyzer for both 4 watt and nominal 1 W power. Modulation corresponded to conditions of 2.989(a) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 910 Hz, the frequency of maximum response. Measured modulation under these conditions was 85% positive, 86% negative.

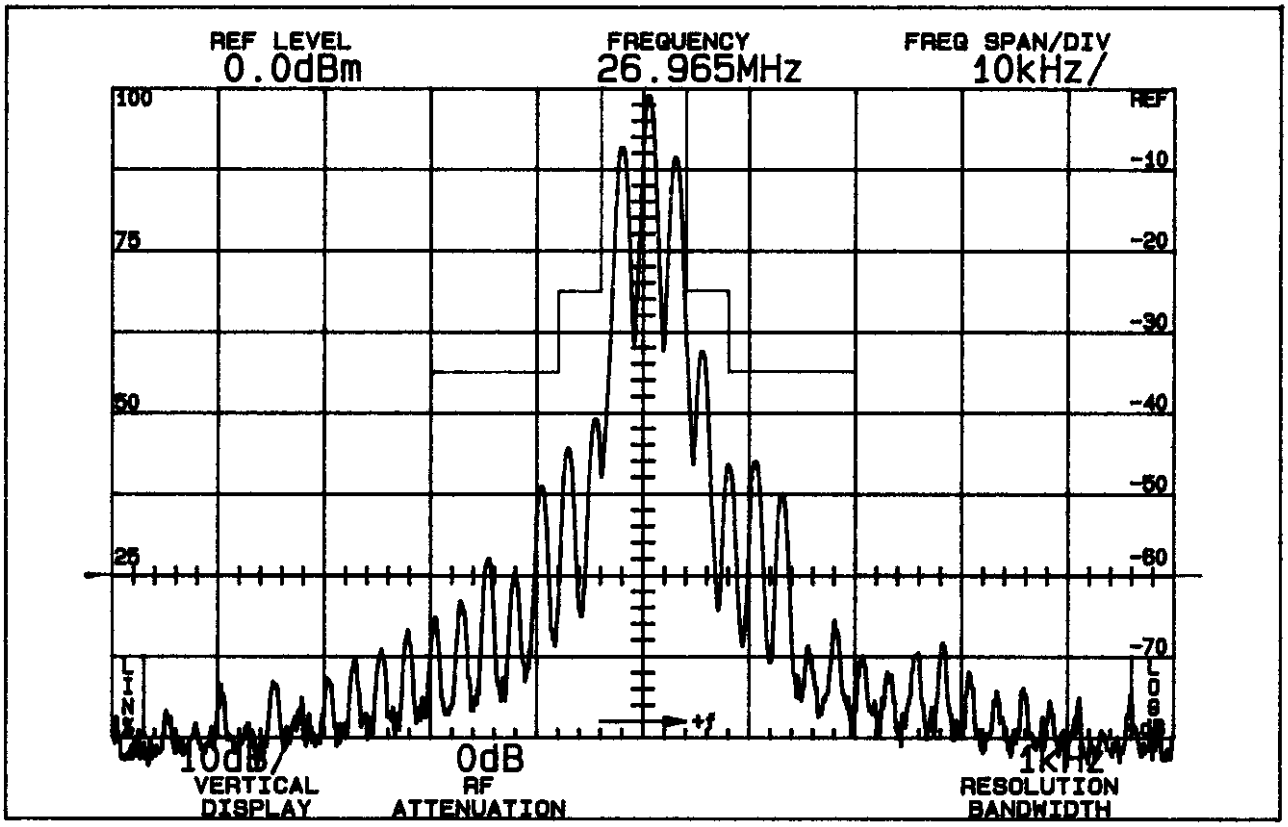
The plot is within the limits imposed by Paragraph 95.631(b)(1,3) for double sideband AM modulation. The horizontal scale, frequency, is 10 kHz per division and the vertical scale, amplitude, is a logarithmic presentation equal to 10 dB per division.

NOTE: CW carrier reference was 0 dBm, top of analyzer screen.

A: \TR8GHZ.CSV

FIGURE 4a

OCCUPIED BANDWIDTH



	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 8kHz (4-8kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (8-20kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth	60

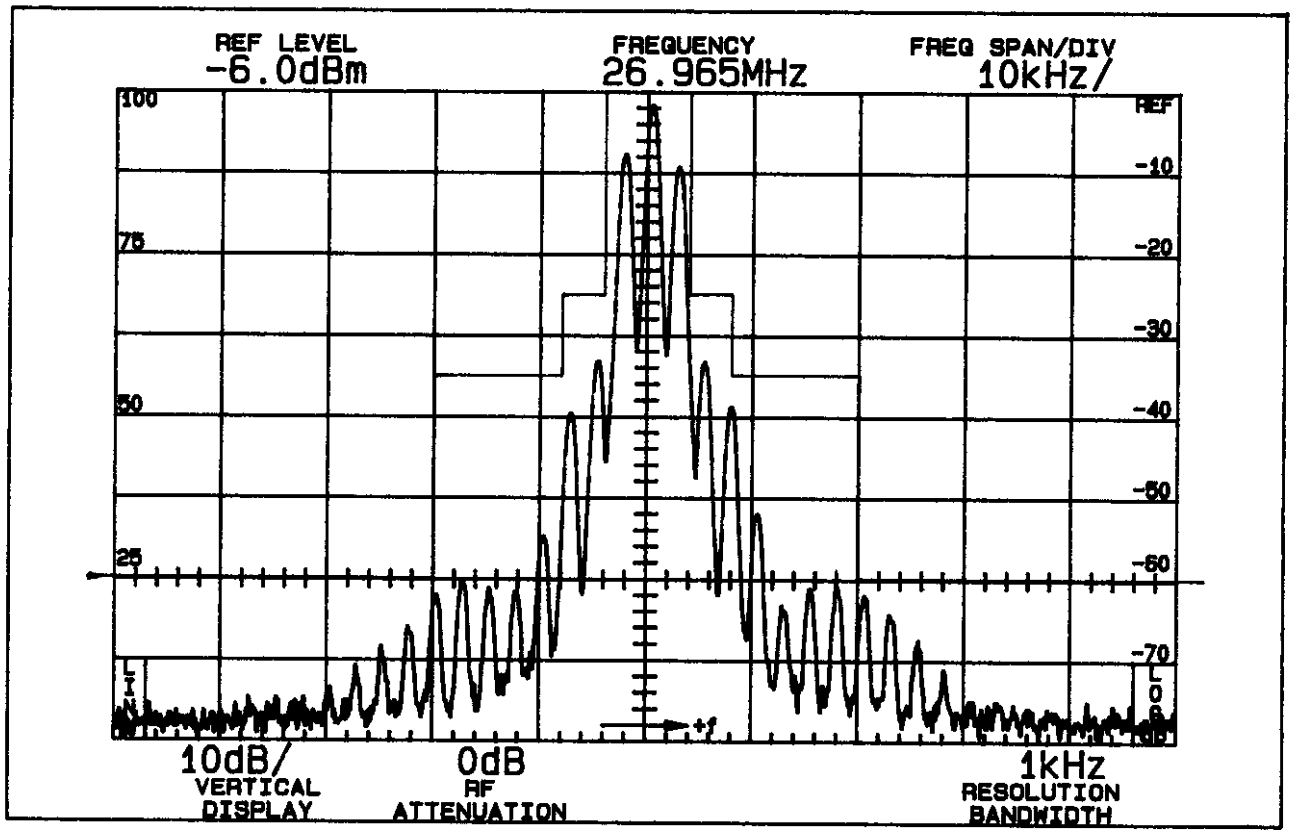
OCCUPIED BANDWIDTH
FCC ID: AAO2101628

FIGURE 4a (High Power)

AI \TRSBLO.CSH

FIGURE 4b

OCCUPIED BANDWIDTH



	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 8kHz (4-8kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (8-20kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth	60

OCCUPIED BANDWIDTH
FCC ID: AAO2101628

FIGURE 4b (Low Power)

D. SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS
(Paragraph 2.991 of the Rules)

The TRC-239 transmitter was tested in the AM mode for spurious emissions at the antenna terminals while the equipnment was modulated with a 2500 Hz signal, 16 dB above minimum input signal for 50% modulation at 910 Hz, the frequency of highest sensitivity.

Measurements were made with Tektronix 494P spectrum analyzer coupled to the transmitter output terminal through Narda 765-20 50 ohm power attenuation.

In order to improve measurement system dynamic range, a series trap tuned to the carrier frequency was used on the Narda attenuator output. The trap, which had negligible attenuation at the second harmonic and higher frequencies, provided 26 dB attenuation of the fundamental. The trap was not used during close-in (within 10 MHz of the carrier) spurious measurements.

During the tests, the transmitter was terminated in the Narda 765-20 dummy load. Power was monitored on a Bird 43 Thru-Line wattmeter; dc supply was 13.8 volts throughout the tests.

Spurious emission was measured at both power settings on Channels 1, 21, and 40 throughout the RF spectrum from 10.24 to 300 MHz. Any emissions that were between the 60 dB attenuation required and the 100 dB noise floor of the spectrum analyzer were recorded. Data are shown in Table.

TABLE 1

TRANSMITTER CONDUCTED SPURIOUS

13.8 Vdc Input

Channel	Spurious Frequency MHz	dB Below Unmod Carrier Ref. "High"	"Low"
1	53.930	88	82
1	80.895	82	84
1	107.860	93	95
1	134.825	92	92
1	161.790	95	86
1	188.755	90	96
1	215.720	94	87
1	242.685	87	86
1	269.650	90	93
21	54.430	90	91
21	81.645	84	84
21	108.860	99	100
21	136.075	94	96
21	163.290	102	98
21	190.505	92	84
21	217.720	101	100
21	244.935	87	88
21	272.150	88	95
40	54.810	89	86
40	82.215	85	83
40	109.620	102	103
40	137.025	94	96
40	164.430	100	94
40	191.835	91	83
40	219.240	102	104
40	246.645	87	88
40	274.050	87	97
	Required:	60	60

All other spurious were more than 20 dB below required 60 dB suppression.

E. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION (Paragraph 2.993(a)(b,2) of the Rules)

Field intensity measurements of radiated spurious emissions from the TRC-239 transmitter were made with a Tektronix 494P spectrum analyzer and dummy load located in an open field 3 meters from the test antenna. Output power was 4.0 watts. The supply voltage was 13.8 volts. The transmitter and test antennae were arranged according to OCE 42 to maximize pickup. The device has no accessory ports. Both vertical and horizontal test antenna polarization were employed.

Measurements were made from 10.24 MHz to 10 times the maximum operating frequency of 26.965 or 269.65 MHz.

Reference level for the spurious radiations was taken as an ideal dipole excited by 4.0 watts, the output power of the transmitter according to the following relationship:*

$$E = \frac{(49.2 \times P_t)^{1/2}}{R}$$

where E = electric-field intensity in volts/meter

P_t = transmitter power in watts

R = distance in meters

for this case $E = \frac{(49.2 \times 4.0)^{1/2}}{3} = 4.7$ V/m

Since the spectrum analyzer is calibrated in decibels above one milliwatt (dBm):

4.7 volts/meter $= 4.7 \times 10^6$ uV/m

dBu/m $= 20 \text{ Log}_{10}(4.7 \times 10^6)$

$= 133$ dBu/m

Since 1 uV/m $= -107$ dBm, the reference becomes

$133 - 107 = 26$ dBm

Representing a conversion for convenience, from dBu to dBm. The measurement system was capable of detecting signals 100 dB or more below the carrier reference level. Data, including antenna factor and line loss corrections, are shown in Table 2.

*Reference Data for Radio Engineers, International Telephone and Telegraph Corporation, Sixth Edition.

F. FIELD STRENGTH MEASUREMENTS (Continued)

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS
Channel 1, 26.965 MHz; 4.0 watts

Frequency, MHz	dB Below Carrier Reference
53.930	73V
80.895	83V
107.860	91H
134.825	79V
161.790	80V
188.755	81H
215.720	93H
242.685	83H
269.650	80H
Required:	60

V/H: Worst-case test ant. polarization.

Any unlisted spurious were more than 80 below carrier reference from 10.24 to 269.650 MHz.

F. FREQUENCY STABILITY
(Paragraph 2.995(a)(1) of the Rules)

Measurement of frequency stability versus temperature was made at temperatures from -30°C to +50°C in 10° increments. At each temperature, the unit was exposed to the test chamber ambient a minimum of 60 minutes after indicated chamber temperature ambient had stabilized to within ±2° of the desired test temperature. Following a 30 minute soak at each temperature, the unit was turned on, keyed and frequency measured within 2 minutes. Test temperature was sequenced in the order shown in Table 3, starting with -30°C.

A Thermotron S1.2 temperature chamber was used. The transmitter output stage was terminated in a dummy load. Primary supply was 13.8 volts. Frequency was measured with a HP 5385A digital frequency counter connected to the transmitter through a power attenuator. Measurements were made on Channel 9, 27.065 MHz. No transient keying effects were observed.

G. FREQUENCY STABILITY (Continued)

TABLE 3

Temperature	Output Frequency, MHz
-29.3	27.065711
-20.1	27.065726
- 9.6	27.065659
- 0.1	27.065540
10.1	27.065376
20.0	27.065147
30.2	27.064960
40.0	27.064784
50.5	27.064635
Maximum frequency error:	27.065726
	27.065000
	+ .000726 MHz

FCC Rule 95.625(b) specifies .005% or a maximum of ± .001353 MHz.

G. FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE (Paragraph 2.995(d)(2) of the Rules)

Oscillator frequency as a function of power supply voltage was measured with a HP 5385A digital frequency counter as supply voltage provided by an HP 6264B variable dc power supply was varied ±15% from the nominal 13.8 volt rating. A Keithley 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient.

TABLE 4

Supply Voltage	Output Frequency, MHz
15.87	27.065205
15.18	27.065178
14.49	27.065158
13.80	27.065147
13.11	27.065143
12.42	27.065144
11.73	27.065150
11.04*	27.065157
Maximum frequency error:	27.065205
	27.065000
	+ .000205 MHz

*Mfg. rated battery end-point.

FCC Rule 95.625(b) specifies .005% or a maximum of ± .0001353 MHz.
No effects on frequency related to keying the unit were observed.

H. ADDITIONAL REQUIREMENTS FOR TYPE CERTIFICATION
(Paragraph 95.665 of the Rules)

The TRC-239 meets the applicable provision of 95.665(a).

External controls are limited to the following per 95.665(a):

1. Primary power connection
2. Internal Microphone
3. RF output power connection
4. N/A
5. On-off switch (combined with receiver volume control)
6. Not applicable, AM only
7. Not applicable, AM only
8. Transmitting frequency selector
9. Transmit-receive switch
10. See #1
11. Not applicable

The serial number of each unit will be implemented in accordance with 95.667.

A copy of Part 5, Subpart D, of the FCC rules for the Citizens Band Radio Service, current at the time of packing of the transmitter, must be furnished with each CB transmitter marketed per 95.669.

I. PLL RESTRICTIONS
(Per Public Notice of April 27, 1978)

The TRC-239 meets the following conditions specified in the April 27, 1978 notice:

1. All frequency-determining elements, including crystals, PLL integrated circuits and channel selector switches are permanently wired and soldered in place.

2. The PLL integrated circuit has no more than six active leads and is BCD encoded.

3. The channel selection mechanism has only 40 positions.

4. The PLL integrated circuit has no "spare" or undedicated leads.

5. A copy of the PLL data sheet is shown in Appendix 9.

9. SEMICONDUCTORS AND FUNCTIONS

1) IC

Ref. No.	Description	Function		Manufacturer
		RX	TX	
IC501	LC7185	PLL IC	PLL IC	SANYO
IC401	KIA7217AP	None	Audio Amp.	K.E.C.
IC551	LM386	Audio Amp.	None	National

2) TR

Ref. No.	Description	Function		Manufacturer
		RX	TX	
Q101	KTC3875S	AGC	-	K.E.C.
Q102	KTC3880S	RF Amp.	-	K.E.C.
Q103	KTC3880S	RX 1ST Mixer	-	K.E.C.
Q201	KTC3880S	RX 2ND Mixer		K.E.C.
Q202	KTC3880S	IF Amp.	-	K.E.C.
Q203	KTC3880S	IF Amp.	-	K.E.C.
Q204	KTA1504Y	ANL Clipping	-	K.E.C.
Q403	KTA1504S	-	ALC TR.	K.E.C.
Q404	KTC3875S	-	ALC	K.E.C.
Q500	KTC3875S	Regulator	Regulator	K.E.C.
Q502	KTA1504S	Digit Switching	Digit Switching	K.E.C.
Q503	KTA1504S	Digit Switching	Digit Switching	K.E.C.
Q510	KTC3875S	PD Amp.	PD Amp.	K.E.C.
Q511	KTC3875S	PD Amp.	PD Amp.	K.E.C.
Q550	KTC3875S	Control SQ.	-	K.E.C.
Q553	KTA1504S	Control SQ.	-	K.E.C.
Q555	KTC3875S	Control SQ.	-	K.E.C.
Q556	KRC110S	Control SQ.	-	K.E.C.
Q601	KTC3880S	Buffer	Buffer	K.E.C.
Q602	KTC3875S	-	TX VCO Switching	K.E.C.
Q603	KTC3880S	VCO	VCO	K.E.C.
Q701	KTC3880S	-	Double	K.E.C.
Q702	KTC3880S	-	PRE Amp.	K.E.C.
Q703	KTC1006	-	RF Driver Amp.	K.E.C.
Q704	KTC2078	-	Power Amp.	K.E.C.
Q900	KTC3875S	Batt. Low	Batt. Low	K.E.C.
Q901	KTC3875S	Batt. Low	Batt. Low	K.E.C.
Q902	KTC3875S	Regulator	Regulator	K.E.C.
Q903	KRA102S	RX B+ Switching	-	K.E.C.
Q904	KRA102S	-	TX B+ Switching	K.E.C.