INSTRUCTION MANUAL

YC-500

YAESU MUSEN CO., LTD.

TOKYO JAPAN

FRECUENCY COUNTER
YC-500

GENERAL DESCRIPTION

The YAESU model YC-500 is a precisely built frequency counter. It is a light weight, completely self-contained frequency measuring instrument of compact design using advanced integrated circuit techniques to enable counting of a wide frequency range, 10 Hz to 500 MHz.

The dual range system provides eight digit measurement with MHz or kHz indication.

The YC-500 series consists of three models depending upon the measurement accuracy—YC-500J for 0.001%, YC-500S for 0.0001%, and YC-500E for 0.000002%.

SPECIFICATIONS

Frequency Range:
Input A – 10 Hz to 50 MHz
Input B – 50 MHz to 500 MHz

Accuracy:
YC-500J model – 10 ppm
YC-500S model – 1 ppm
YC-500E model – 0.02 ppm

Display Digit:
6 digits

Display Time:
0.1 or 2 seconds

Counting Time:
0.001 or 1 second

Input Voltage:
Input A – 25 mV to 20V r.m.s. (HIGH)
25 mV to 2V r.m.s. (LOW)
Input B – 100 mV to 2V r.m.s.

Input Impedance:
Input A – HIGH 1 Meg ohm, LOW 50 ohms
Input B – 50 ohms

Input Capacitance:
Input A – Less than 20 PF
Input B – Less than 25 PF

Operating Temperature:
0 to 40°C

Power Requirement:
AC – 100/110/117/200/220 or 234V, 50/60 Hz
DC – 12 to 14.5V

Size:
220 W x 80 H x 235 D m/m

Weight:
approximately 3.2 kg

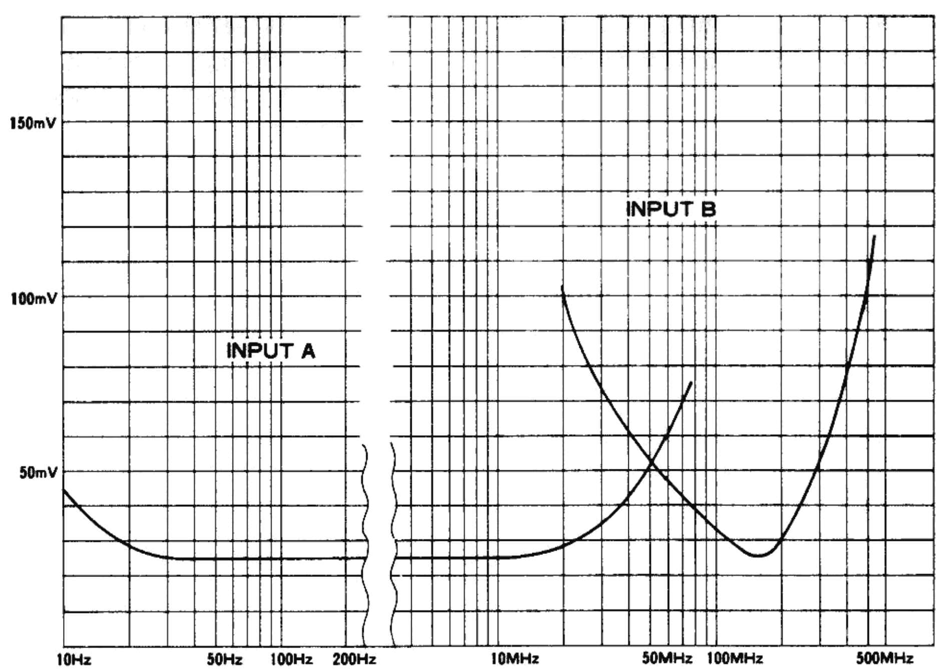


Figure 1 Characteristic of Frequency Response

CONTROLS AND SWITCHES

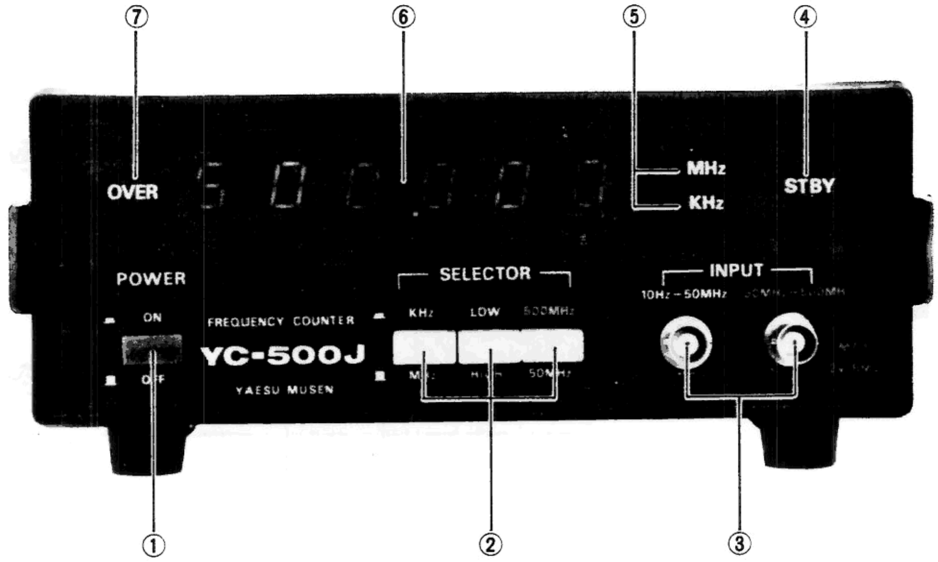


Figure 2 FRONT PANEL

(1) POWER "ON/OFF" SWITCH

The POWER switch turns the frequency counter "ON" and "OFF" for both AC and DC operations. With the switch pushed in position, the power is supplied to all circuits for both AC or DC operation. The crystal oscillator is connected to the supply when the power cord is connected to the power outlet or battery regardless of the POWER switch position and STBY lamp light-up..When it is not in use for long periods, the power cord should be disconnected from the power source.

(2) SELECTOR SWITCHES

MHz/kHz

When the range switch is pushed in, a kHz indicator lights up and the digits to the decimal point are kHz. In the switch out position, a MHz indicator lights up and the digits to the decimal point are MHz.

HIGH/LOW

This switch selects input impedance of "A" input. With the switch pushed in, the input impedance is 50 ohms and with the switch in outer position, the input impedance is 1M ohm. Input impedance of input "B" is 50 ohms regardless of the switch position.

50 MHz/500 MHz

This switch selects the signal range of either 50 MHz or 500 MHz. With the switch pushed in, the frequency range is 50 MHz to 500 MHz and when the switch is in the outer position, the range is 10 Hz to 50 MHz.

(3) INPUT

Input "A" is used for the measurement up to 50 MHz and input "B" is used for the 50 – 500 MHz range. The input impedance of input "A" is selected to either 1M ohm or 50 ohms by the SELECT switch. The maximum input voltage to input "A" is 20V r.m.s. for high impedance or 2V r.m.s. for low impedance. Input "B" has 2V r.m.s. maximum input voltage.

(4) STBY

The crystal oscillator circuit is connected to the power when the power cord is connected to the power source and the STBY lamp lights up.

(5) OVER

This is an OVER range indicator lamp which will flash on when the input frequency is higher than the display frequency.

REAR PANEL CONNECTIONS

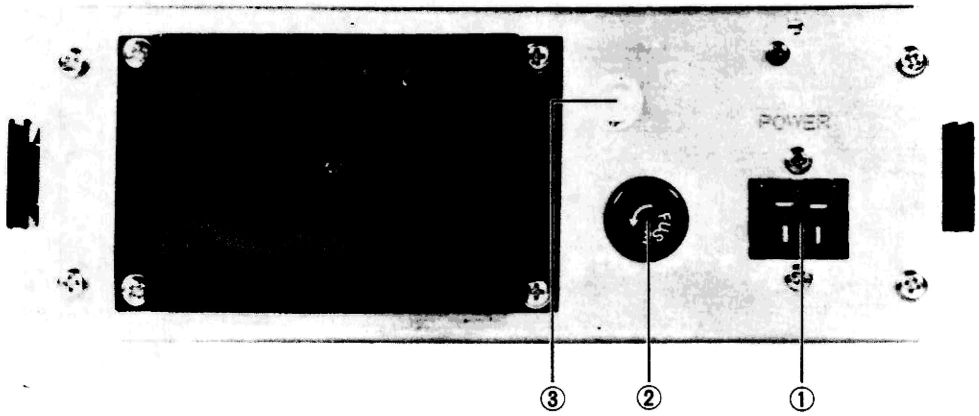


Figure 3 Rear Panel

(1) POWER

This socket accepts the plug on either AC or DC cord

(2) FUSE

Fuse holder for AC operation

(3) 1 MHz OUTPUT

The output terminal of an internal 1 MHz clock oscillator signal

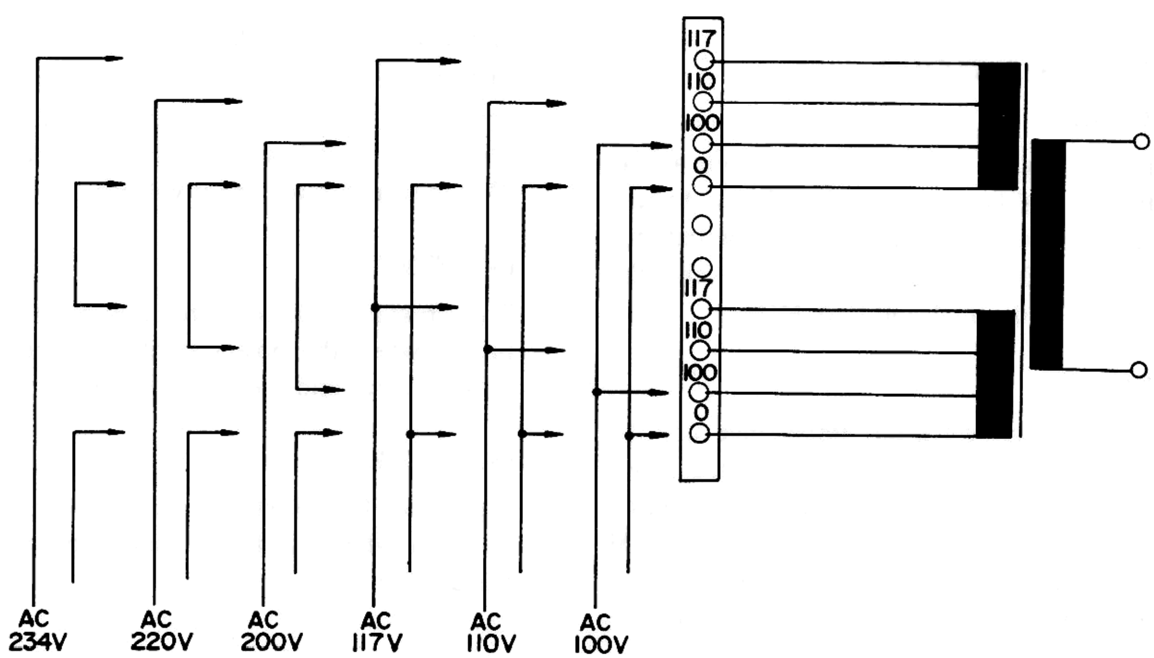


Figure 4 Transformer Primary Wiring

OPERATION

CAUTION

PERMANENT DAMAGE WILL RESULT IF IMPROPER AC OR DC SUPPLY VOLTAGE IS APPLIED TO THE COUNTER.

THE FOLLOWING PRECAUTIONS ARE NECESSARY WHEN USING THIS FREQUENCY COUNTER.

(1) Supply voltage should be within ±10%.

(2) Prior to connecting the power cord, the power switch should be in "OFF" position to avoid being damaged due to transient voltage which may be caused by the connection of cord.

(3) For DC operation, the red cable should be connected to (+) plus terminal and the black cord to (–) minus terminal of battery. A fuse will blow if connection is reversed.

(4) When the power cord is connected to the power source, the clock oscillator circuit is working, even with the POWER switch "OFF". Therefore, it is recommended that the power cord is disconnected from the supply source when the counter is not being used for a long period of time.

(5) In order to get accurate frequency measurement, it is recommended that you allow the counter to warm up for at least one hour.

(6) It is recommended that the counter be used at an ambient temperature of 0°C to 40°C.

(7) Avoid any shocks to the counter and handle it carefully.

(8) Attention should be paid in regard to the wave form of the input signal. A distorted signal may cause erratic measurement.

(9) The input voltage should not exceed 20V r.m.s. at input "A" and 2V r.m.s. at input "B".

OPERATION

PREPARATION

Set the power switch to "OFF" position. Connect an appropriate cord (AC or DC cord) to the power receptacle on rear panel. The STBY lamp lights up showing the clock oscillator is working. It is recommended to allow one hour warm-up prior to measurement for accurate measurement. However, it is not necessary to wait for one hour for normal measurement.

Connect measuring cable to one of the inputs, "A" or "B". Input "A" is used for measurement of frequencies below 50 MHz and input "B" is used for frequencies higher than 50 MHz.

Push the POWER switch to "ON" position. Connect the other end of the measuring cable to the measuring point; black clip is for ground.

FREQUENCY MEASUREMENT

Below 50 MHz:

Use input "A" and set the range switch to outer position. The YC-500 has six numerical displays, however, it is possible to read to eight digit accuracy.

For example, if the range is set to MHz and display shows 12.346 MHz, the actual frequency is between 12.345 MHz and 12.346 MHz. When the range switch is set to kHz, then the following three digits can be read. It may now shows 345.678 kHz and the actual frequency is 12,345.678 kHz. However, the last digit is either 7 or 8 as the counter always shows a one count discrepancy as illustrated in Fig. 5.

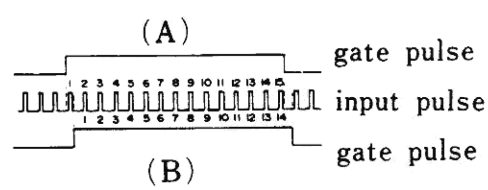


Figure 5

The over range lamp will flash if the input frequency is higher than the frequency displayed. No damage will result if the counter is operated continuously under over range conditions. The lamp merely indicates that the true frequency is not being displayed and may lack upper portion of digits.

The input impedance of input "A" can be selected by the switch on front panel to either 50 ohms or 1M ohm to minimize the effect of the counter on the circuit measured. The 1M ohm position may be used to minimize the loading on the circuit and 50 ohms may be used to minimize a stray pick-up from other signal sources.

Over 50 MHz:

Use input "B" and set the range switch to the push down position. Read frequency as described for frequency below 50 MHz. The impedance of input "B" is 50 ohms and cannot be changed by the HIGH/LOW switch.

NOTE: If the signal to be measured has some harmonic content, then, depending on the input level, the counter may show fundamental or harmonic frequency.

ACCURACY OF COUNTER

When measuring frequency with a frequency counter, there are always errors inherent in the system which cannot be avoided.

These errors are:

(1) Standard clock oscillator error.

(2) Counting error associated with input gate.

The first error results when the frequency of the clock oscillator crystal changes due to temperature or aging. If the crystal frequency increases by 1%, the gate time is reduced by 1% which causes a −1% error in indicated frequency.

The YC-500 series consists of three models the difference being the accuracy of the clock oscillator:

YC-500J – 0.001%
YC-500S – 0.0001%
YC-500E – 0.000002%

In the YC-500E the crystal accuracy is 0.000002% which represents a maximum error of 1 Hz at 50 MHz.

The second error is always present in any frequency counter and is called a one count error. This error results when the gate opens just before a pulse or just after a pulse and causes and error of +1.

The counter counts the number of pulses that pass through the gate. If the gate opens as in the top drawing (A) in Fig. 1, the counter will count 15 pulses. If it opens as in the bottom drawing (B), it will count 14 pulses although the frequency is the same for both cases.

This error occurs for the last digit only. Hence, on the YC-500 the error is 1 Hz on the kHz range and 1 kHz on the MHz range.

This error must be considered when measured frequency occupies only the first two digits on either range.

The signal from input "A" (10 Hz – 50 MHz) is amplified by Q_{401}, **2SK19GR** and fed through a diode switch, D_{407} and D_{408}, **IN60FM** to a Schmitt trigger where the input signal is converted into a square wave of constant amplitude regardless of wave form of input signal.

The signal from input "B" (50 MHz – 500 MHz) is fed to the pre-scaler Q_{402}, **SP-631B** where the signal is divided by ten. The divided output is then fed through a diode switch, D_{407} and D_{408}, **1N60FM** to the Schmitt trigger circuit.

The diode D_{401} through D_{404} clips the signal when the excessive amplitude signal is applied to the input terminal.
Q_{404}, **MPS-3640** sets the output level of Q_{403} to match the operating level of TTL integrated circuit. The pulse width is set by TC_{401}.

The output from Q_{404} is then fed to the gate circuit composed of Unit 1 of Q_{211}, **SN74S11N** which passes the pulses while the gate opens and the pulses are sent to Q_{208}, **SN74196N.**

Unit 3 of Q_{211} is used as a second gate and Unit 2 is used to stretch the pulse width for stable counting of Q_{205}, **SN74143N.**

The pulse passed through the first gate is fed to the last digit counter Q_{208}, **SN74196N** which counts the number of pulses passing through the gate. The BCD code output from Q_{208} is fed to a 4-bit latch memory IC, Q_{207}, **SN7475N** which stores the binary information between counting unit and indicator unit.

The latch memory is required to prevent the numeric indicators from following each count

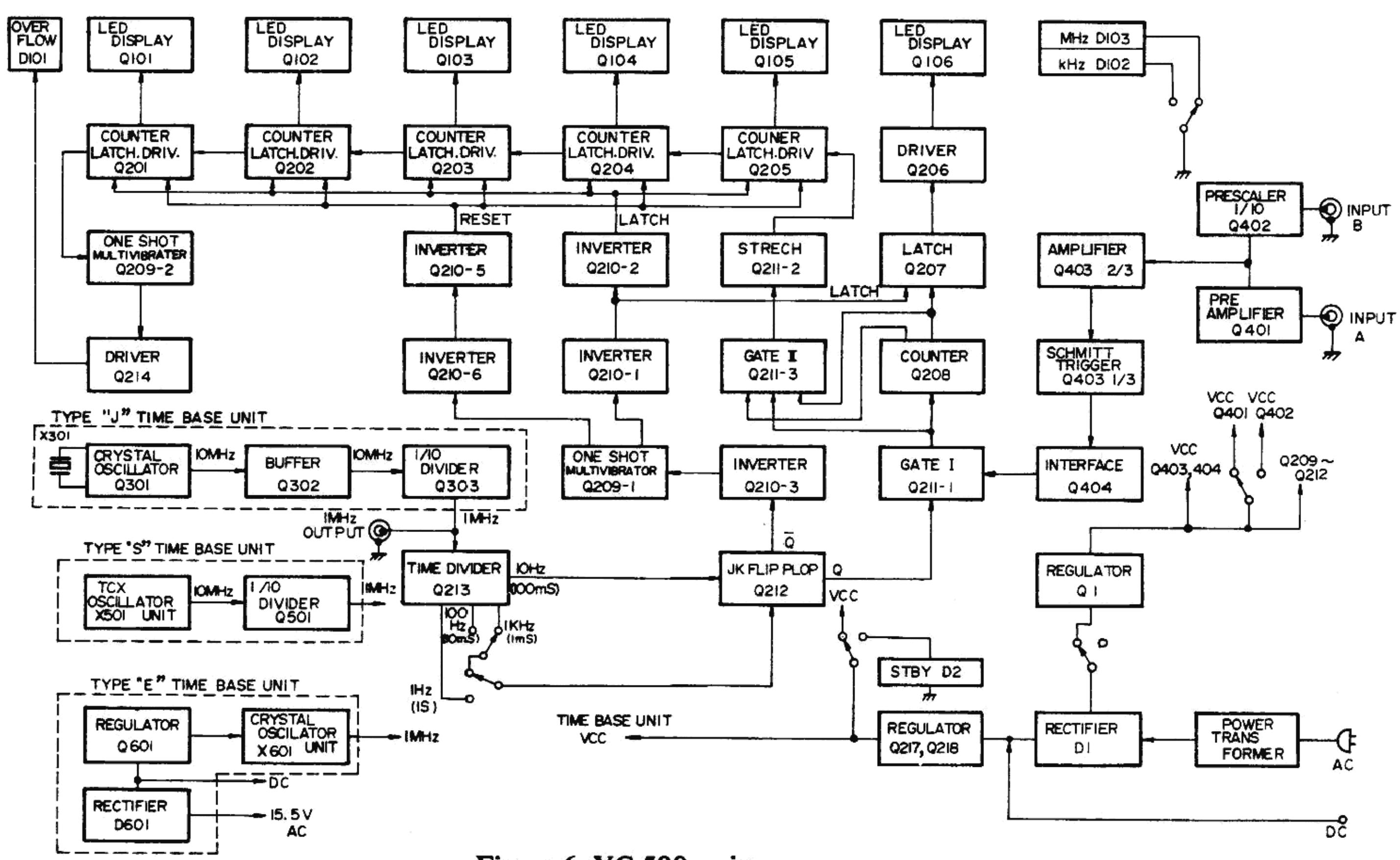


Figure 6 YC-500 series BLOCK DIAGRAM

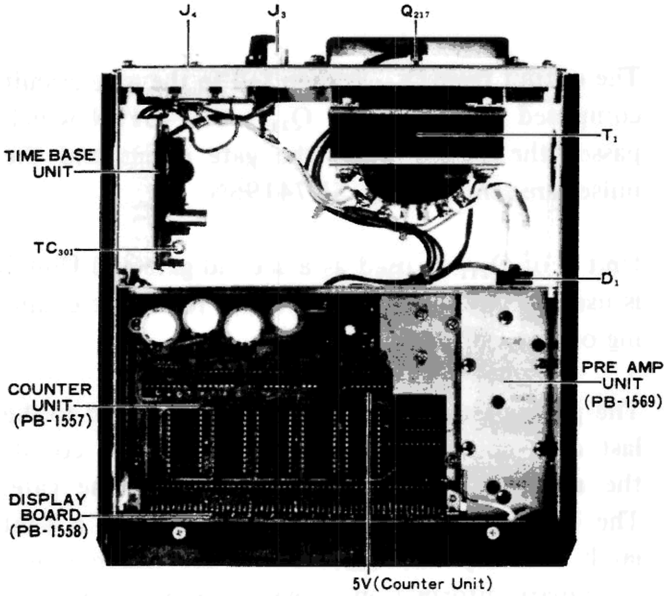


Figure 7 Top View

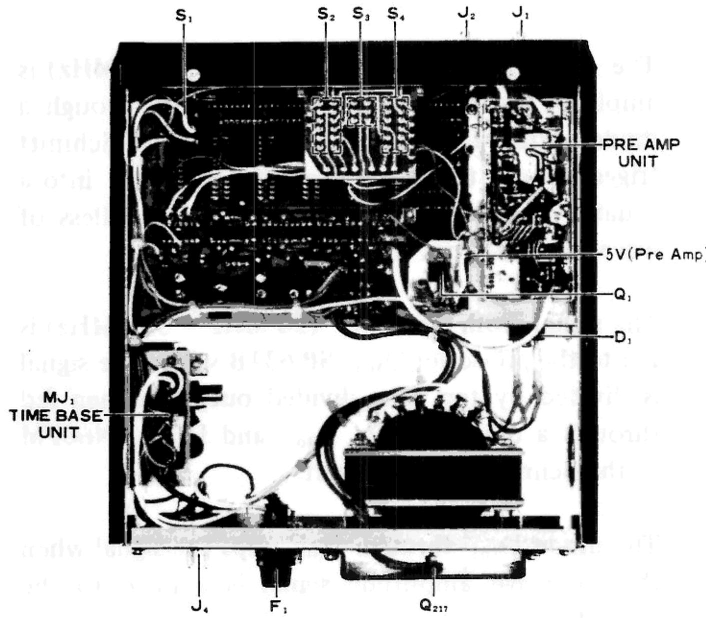


Figure 8 Bottom View

when the gate opens. The result is that the frequency measured in one count is held in the indicators while the next count is being made, then they change when the count is completed.

The binary coded output from Q_{207} is fed to Q_{206}, **SN74247N** where the binary coded signal is converted into decimal numbers to be displayed by the indicator Q_{106}, **5082-7750.**

The QA and QD components of the binary coded output from Q_{208} pass through the second gate and are fed to Q_{205}, **SN74143N** where the binary coded signal is converted to be displayed by Q_{105}. Q_{205} functions as a counter, latch and decoder.

When the counter, latch and decoder IC, Q_{205}, Q_{204}, Q_{203}, Q_{202} and Q_{201} count to 10, they produce a pulse to be fed to upper counter. If the number of pulses passing through the gate is greater than the counting capacity of Q_{201}, the overflow from Q_{201} is fed to the one-shot multivibrator Q_{209}, **SN74123N** producing an overflow indicator signal which is fed through lamp driver Q_{214}, **2SC735Y** to the over range lamp D_{101}, **SL103.**

The clock oscillator circuit is composed of 10 MHz crystal oscillator Q_{301}, **2SC828Q** and a buffer amplifier Q_{302}, **2SC828Q.** The divider Q_{303}, **SN7490N** divides the 10 MHz signal by 10 producing a 1 MHz clock signal.

The 1 MHz signal is fed to divider Q_{213}, **MSM5592** which produces 1 kHz, 100 Hz, 10 Hz and 1 Hz signals.

The 10 Hz signal is fed to "J" input (Pin 5) and the others are fed to clock input (Pin 12) for range selection.

Q_{209}, **SN74123N** and Q_{210}, **SN7404N** are used to produce reset and set pulses.

On AC operation, the transformer secondary voltage 8.7 Volts AC is rectified by a bridge connected rectifier D_1,**S4VB-10** and then regulated by Q_{217}, **MJE700** and Q_{218}, **F78L05** to supply 5V to ICs. The 5V regulated supply is directly connected to clock oscillator. With the POWER switch "ON", +5V is fed to the counter unit. A part of rectified DC voltage is fed through the power switch to the regulator, Q_1, **μPC14305** which supplies regulated 5V to the preamplifier unit.

In the "E" model, the AC 15.5 Volt supply is rectified by D_{601}, **S1RBA** and regulated by Q_{603}, **μPC14312** to 12 Volts which is used for the heat chamber and crystal oscillator circuit.

In DC operation, the 12V DC supply is connected through R_1 to the output of D_1.

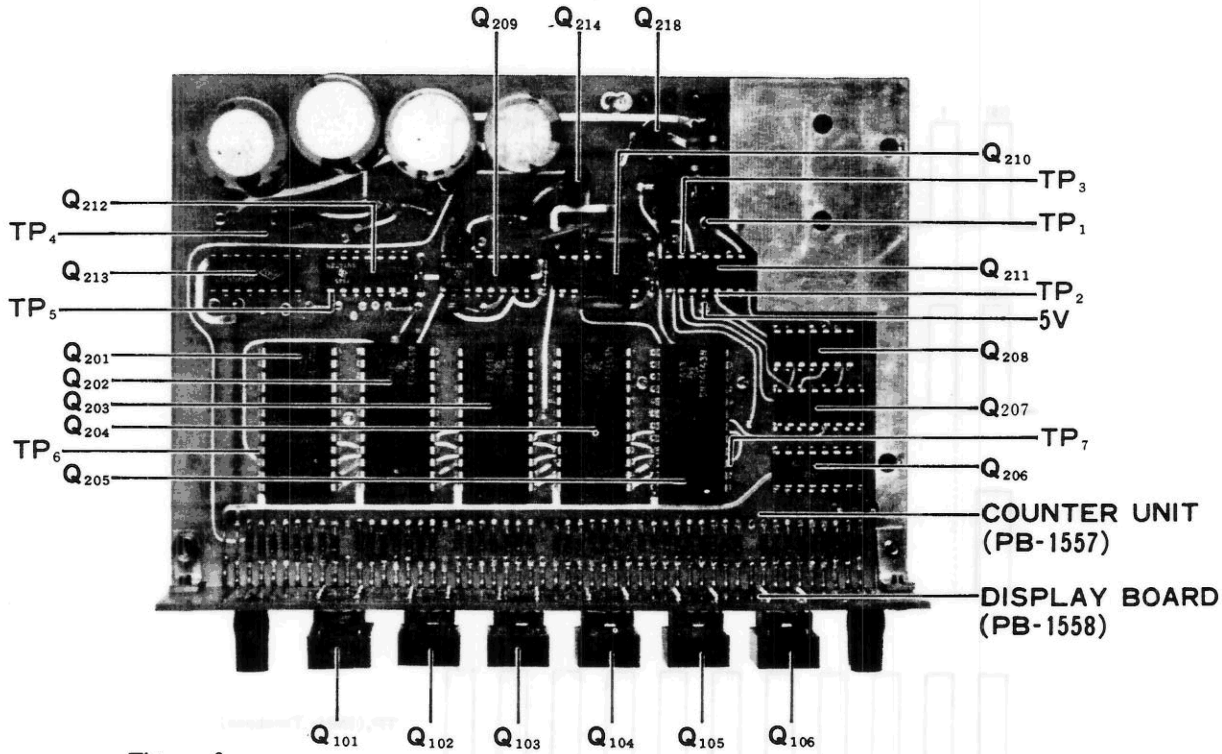


Figure 9

COUNTER-DISPLAY UNIT

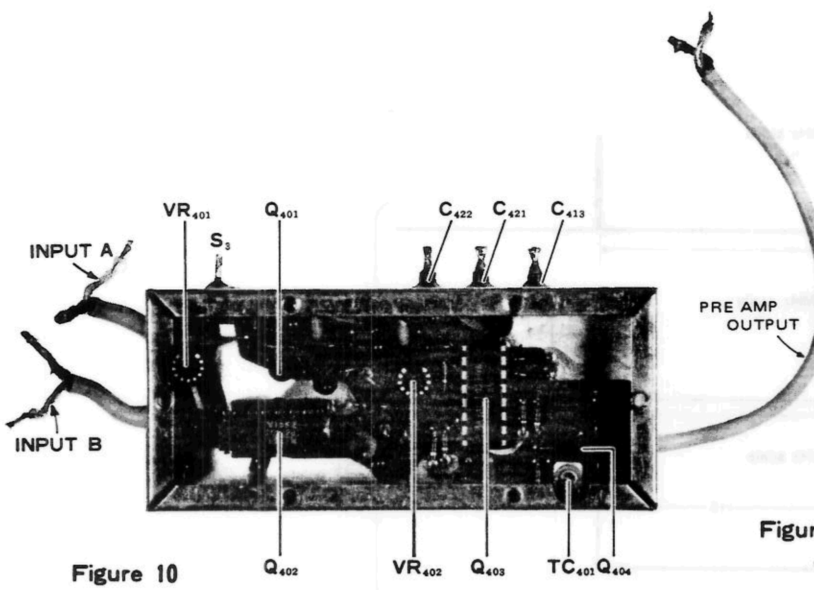


Figure 10

PRE AMP UNIT (PB-1569)

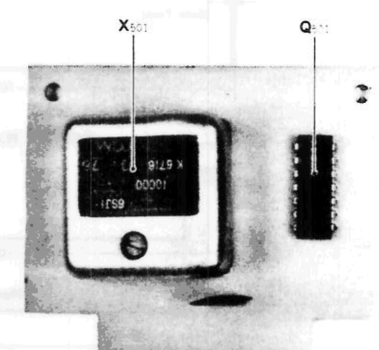


Figure 12

TIME BASE UNIT "S" (PB-1562)

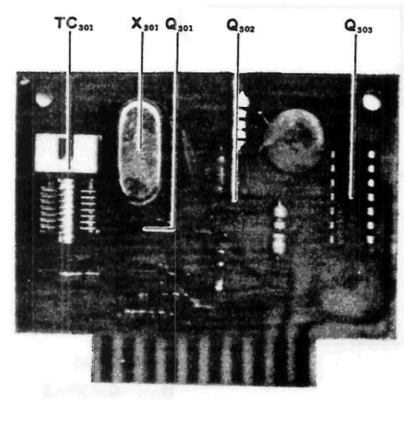
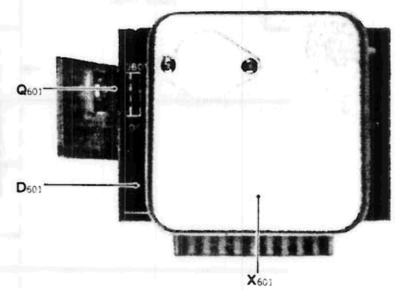


Figure 11

TIME BASE UNIT "J" (PB-1561)



TIME BASE UNIT "E" (PB-1563)

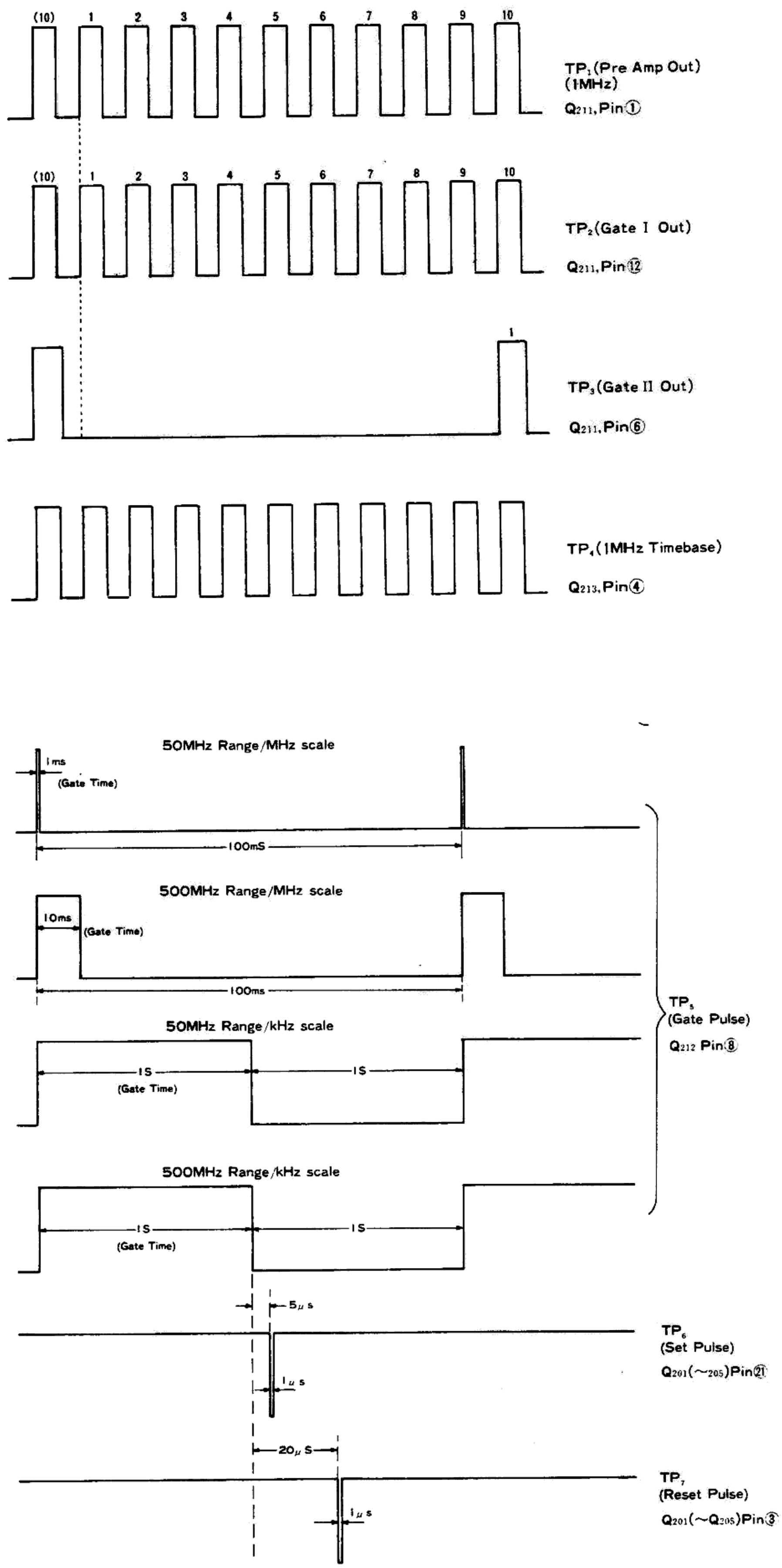


Figure 12 Waveforms

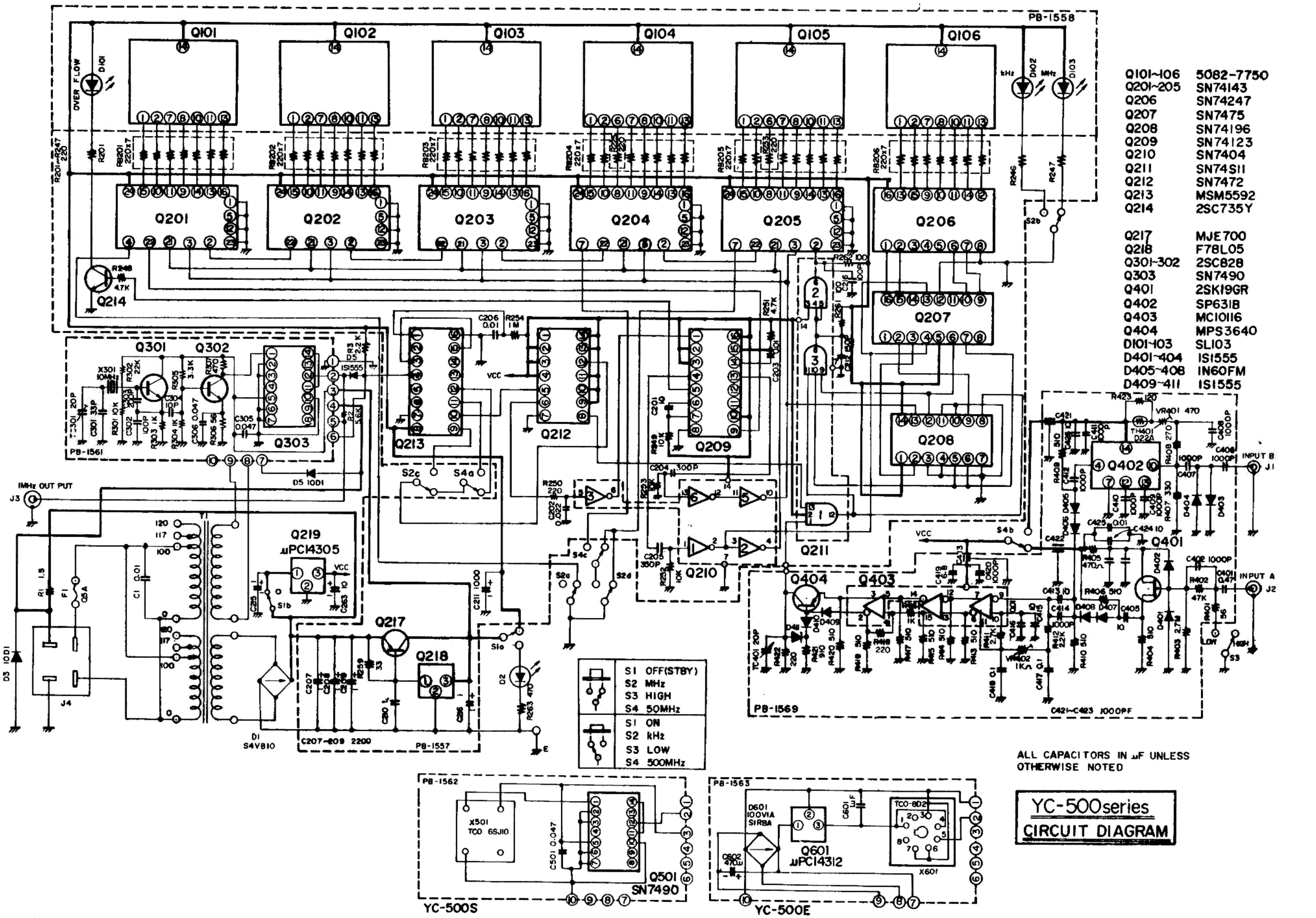

Q101~106 5082-7750
Q201~205 SN74143
Q206 SN74247
Q207 SN7475
Q208 SN74196
Q209 SN74123
Q210 SN7404
Q211 SN74S11
Q212 SN7472
Q213 MSM5592
Q214 2SC735Y
Q217 MJE700
Q218 F78L05
Q301~302 2SC828
Q303 SN7490
Q401 2SK19GR
Q402 SP6318
Q403 MC10116
Q404 MPS3640
D101~103 SL103
D401~404 IS1555
D405~408 IN60FM
D409~411 IS1555
S1 OFF(STBY)
S2 MHz
S3 HIGH
S4 50MHz
S1 ON
S2 kHz
S3 LOW
S4 500MHz
ALL CAPACITORS IN µF UNLESS OTHERWISE NOTED
YC-500series
CIRCUIT DIAGRAM
YC-500S
YC-500E
PB-1558
PB-1561
PB-1557
PB-1569
PB-1562
PB-1563
INPUT A
INPUT B
1MHz OUT PUT
OVER FLOW

Figure 13

D	**DIODE**		
1	Si Bridge		S4VB10
3.4	Si		10D1
5	Si		1S1555
2	LED		SL103
R	**RESISTOR**		
	CARBON FILM		
3		1/8W	2.2KΩ
2		1/8W	5.6KΩ
	WIRE WOUND (CEMENT)		
1		10W	1.5Ω
C	**CAPACITOR**		
	CERAMIC DISC		
1		1.4KV	0.01μF
T	**POWER TRANSFORMER**		
1		52-49	
S	**SWITCH**		
1			MPS-U
2,4			3FS-40
3			3FS-20-15
PB-1570	**SWITCH BOARD (S2~S4)**		
J	**RECEPTACLE**		
1,2,3			UG 625B/O
4			1B4E
MJ	**MULTI JACK**		
1		3305-010-011	10P
F	**FUSE**		
1			0.5A(AC)
FH	**FUSE HOLDER**		
1			F-7152

DISPLAY BOARD

PB	**PRINTED CIRCUIT BOARD**		
1558(A~Z)			
Q	**DISPLAY LED**		
101~106			5082-7750
D	**DIODE**		
101~103		LED	SL-103
QS	**LED SOCKET**		

COUNTER UNIT

PB	**PRINTED CIRCUIT BOARD**		
1557(A~Z)			
Q	**IC & TRANSISTOR**		
210		IC	SN7404N
211		IC	SN74S11N
212		IC	SN7472N
207		IC	SN7475N
209		IC	SN74123N
201~205		IC	SN74143N
208		IC	SN74196N
206		IC	SN74247N
213		IC	MSM5592
218		IC	F78L05AC
219		IC	μPC14305
214		Tr	2SC735Y
217		Tr	MJE700
R	**RESISTOR**		
	CARBON COMPOSITION		
261,262		1/8W	91Ω
201,225,233,246,247,250		1/8W	220Ω
263		1/8W	470Ω
247,251		1/8W	4.7KΩ
249,252,253		1/8W	10KΩ
254		1/8W	1MΩ
259		1/2W	33Ω
RB	**BLOCK RESISTOR**		
201~206		1/8W	220Ω × 7
C	**CAPACITOR**		
	DIPPED MICA		
215		50WV	150PF
204		50WV	300PF
205		50WV	350PF
	CERAMIC DISC		
212		50WV	150PF
206		50WV	0.01μF
	CERAMIC CHIP		
213		25WV	0.01μF
	MYLAR		
203		50WV	0.01μF
202		50WV	0.022μF
	TANTALUM		
201		16WV	10μF
	ELECTROLYTIC		
210,214,215		16WV	1μF
217		16WV	10μF
211		16WV	1000μF
207~209		16WV	2200μF
QS	**IC SOCKET**		
201			314-AG37D

PREAMP UNIT

PB	**PRINTED CIRCUIT BOARD**		
1569(A~Z)			
Q	**IC, FET & TRANSISTOR**		
402		IC	SP631B

403		IC	MC10116
401		FET	2SK19GR
404		Tr.	MPS3640
D	**DIODE**		
405~408		Ge	1N60FM
401~404, 409~411		Si	1S1555
R	**RESISTOR**		
	CARBON COMPOSITION		
401		1/8W	56Ω
422		1/8W	110Ω
423		1/8W	120Ω
418		1/8W	220Ω
408		1/8W	270Ω
407		1/8W	330Ω
405		1/8W	470Ω
404, 406, 409, 410, 413~415 417, 419, 420		1/8W	510Ω
421		1/8W	910Ω
416		1/8W	1KΩ
412		1/8W	2.2KΩ
411		1/8W	2.7KΩ
402		1/8W	47KΩ
403		1/8W	2.7MΩ
TH	**THRMISTOR**		
401			D-22A
VR	**POTENTIOMETER**		
401	PN822H501H		470Ω
402	PN822H102H		1KΩ
C	**CAPACITOR**		
	CERAMIC DISC		
402, 412, 414, 420		50WV	0.001μF
403, 416, 425		50WV	0.01μF
	CERAMIC CHIP		
406~411		25WV	0.001μF
427		25WV	0.01μF
	CERAMIC FEED THRU		
421~423		50WV	0.001μF
	TANTALUM		
417, 418		35WV	0.1μF
419		35WV	6.8μF
404, 405, 413, 415, 424, 426		35WV	10μF
	MYLAR		
401		100WV	0.47μF
TC	**TRIMMER CAPACITOR**		
401	ECV-1ZW 20×53		20PF
QS	**IC SOCKET**		
401			314-AG37D
402			316-AG37D
TIME BASE UNIT (J)			
PB	**PRINTED CIRCUIT BOARD**		
1561 (A~Z)			
Q	**IC & TRANSISTOR**		
303		IC	SN7490AN
301, 302		Tr	2SC828Q
X	**CRYSTAL**		
301		HC-6/U	10MHz

R	**RESISTOR**		
	CARBON FILM		
306		1/4W	56Ω
307		1/4W	470Ω
303, 304		1/4W	1KΩ
305		1/4W	3.3KΩ
301		1/4W	10KΩ
302		1/4W	22KΩ
C	**CAPACITOR**		
	DIPPED MICA		
304		50WV	10PF
302		50WV	100PF
303		50WV	200PF
	CERAMIC DISC		
301		50WV	33PF(NPO)
305, 306		50WV	0.047μF
TC	**TRIMMER CAPACITOR**		
301	TSN-P-100DS		20PF
TIME BASE UNIT(S)			
PB	**PRINTED CIRCUIT BOARD**		
1562 (A~Z)			
Q	**IC**		
501			SN7490AN
X	**TCXO**		
501			TCO6SJ10
C	**CAPACITOR**		
	CERAMIC DISC		
501		50WV	0.047μF
TIME BASE UNIT(E)			
PB	**PRINTED CIRCUIT BOARD**		
1563 (A~Z)			
Q	**IC**		
601			μPC14312
D	**DIODE**		
601		S1RBA	100V 1A
X	**CRYSTAL OSCILLATOR**		
601			TCO-8D2
C	**CAPACTOR**		
	TANTALUM		
601		35WV	1μF
	ELECTROLYTIC		
602		25WV	470μF

YAESU