

# **INSTRUCTION MANUAL**

**FUNCTION GENERATOR**

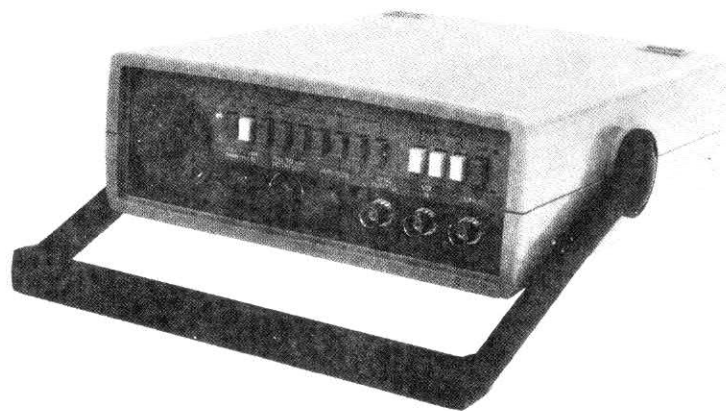
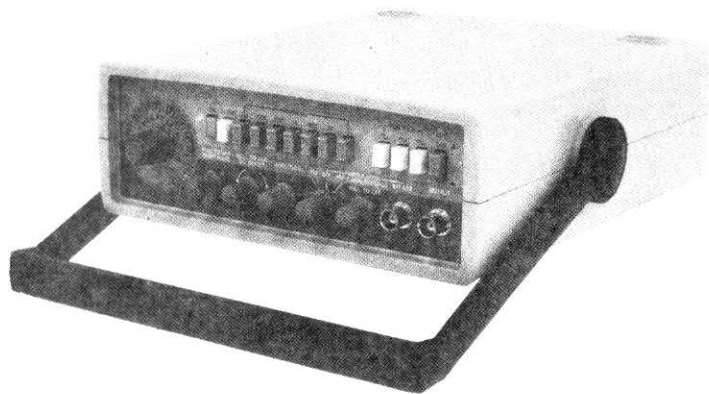
**Model 8102/8105**



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PICTURE of MODEL: 8102/8105



## INTRODUCTION

The Topward 8102 and 8105 are portable, bench type function generators capable of producing 5 different waveforms. These are sine, square, triangle, pulse and ramp. Model: 8105 can also amplitude and/or frequency modulate the output signal.

Output frequency is adjustable from .1 Hz to 2 MHz in 7 ranges. The DC offset of all waveforms can be adjusted between + and - 10 volts by a front panel adjustment. The duty cycle of the ramp and pulse outputs can be continuously adjusted between 20% and 80%.

Both models have a voltage controlled frequency input (VCF in) that allows the frequency to be adjusted or swept by an external source. The Topward TFG-8105 has an additional input to allow the output amplitude and frequency to be modulated by an external source.

## BEFORE WE BEGIN

Your Topward 8102/8105 is packed in styrofoam to protect it during shipment. You should keep this material, as well as the shipping box, in case the unit must be moved or shipped again.

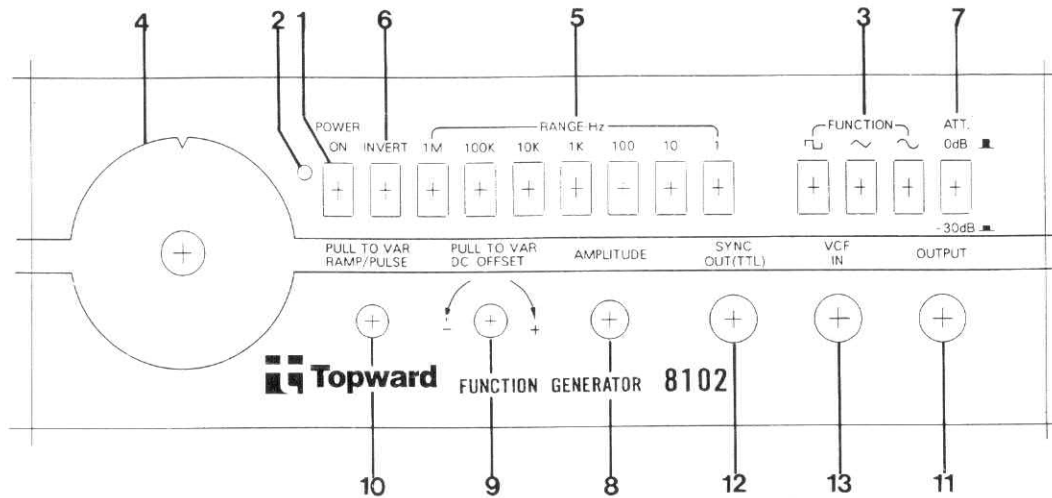
The box should include the following items:

Model: 8102 or 8105 Function Generator  
Removable AC line cord  
BNC to Alligator clip output cable  
Instruction manual

Please check to see that all of the above items are included. You should contact your Topward dealer if anything is missing.

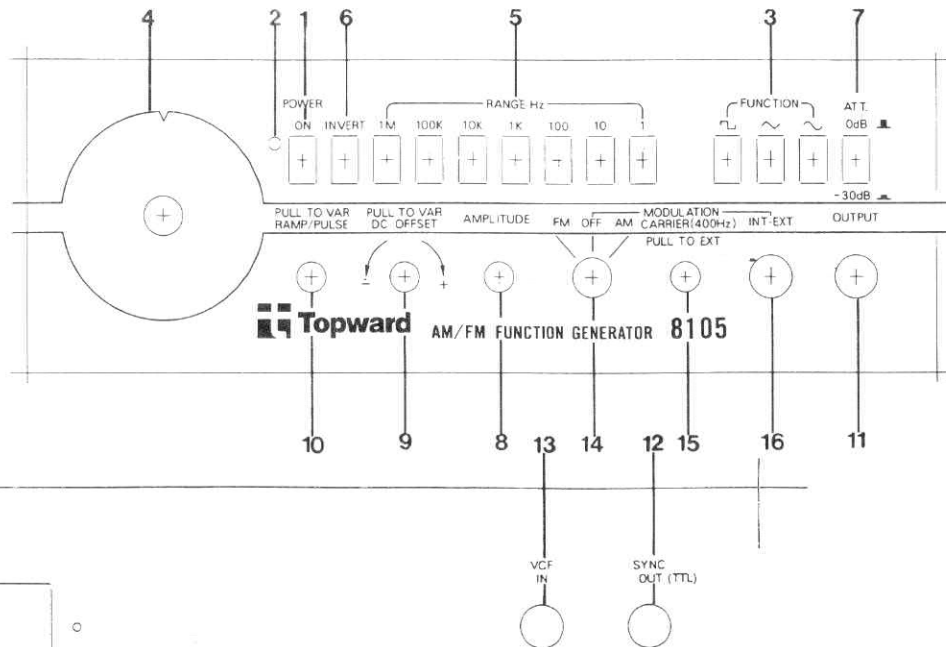
FRONT PANEL OF MODEL: 8102

Figure 1



# FRONT AND REAR PANELS OF MODEL: 8105

Figure 2



~ LINE Δ	
10VA MAX	50.60Hz
115V	230V
105V TO 125V	210V TO 250V
0.5A	0.3A
Δ SEE MANUAL TO CHANGE ~ V	

## FRONT PANEL DESCRIPTION

The following is an explanation of the function of each of the front and rear panel controls and connectors. Those features that are only available on the 8105 are so indicated in the text. You should refer to Figures 1 through 3 for the location of each control/connector.

1. **POWER ON** - This is the main power switch. It is a push on/push off type.
2. **POWER INDICATOR LED** - This LED is on whenever the **POWER ON** switch (1) is depressed.
3. **FUNCTION** - This bank of switches is used to select the output waveform. Only one of these switches can be depressed at a time.
4. **FREQUENCY CONTROL** - This knob is used to adjust the output frequency. The frequency is dependent on the setting of this knob and the **RANGE** switch (5) explained below.
5. **RANGE** - This bank of interlocked switches is used to select the frequency range produced. The actual output is the product of the depressed switch and the setting of the **FREQUENCY CONTROL** (4) dial.
6. **INVERT** - This switch will invert the polarity of the output signal (180



degree phase shift).

7. **ATTENUATION** - When this push button is out, the signal is passed to the output unchanged. If the switch is depressed, the output signal is attenuated by 30 dB.

8. **AMPLITUDE** - This adjustment sets the signal level of the output. Turning the control clockwise will increase the amplitude.

9. **DC OFFSET** - This adjustment knob allows a DC voltage to be added to the output signal. Note that the knob has to be pulled out for the offset to affect the signal. When the control is pushed in, no offset voltage is added.

10. **DUTY CYCLE ADJUST** - This combination switch/adjustment is used to adjust the duty cycle of the square/pulse and ramp/triangle waveforms. When the knob is pushed in, the duty cycle is fixed at 50%. When pulled out, the duty cycle is adjustable between 20 and 80%

11. **OUTPUT** - This BNC connector provides the output signal for all waveforms.

12. **SYNC** - This connector supplies a TTL compatible signal. The output is unaffected by either the **FUNCTION** select (3) or **AMPLITUDE** (8) controls. The output frequency is the same as that provided on the **OUTPUT** connector (11) and will be affected by the **DUTY CYCLE** adjustment (10).

13. VCF IN - This input is used to modulate the frequency with an external source.

NOTE: The following controls/connectors are only supplied on the model: 8105.

14. MODULATION SELECT - This three position switch is used to select the output modulation method. When in the FM position, the signal INT-EXT connector (16) is used to modulate the output frequency. When it is placed in the center position, no modulation is applied to the output signal. In the far right position, the signal on the INT-EXT connector (16) is used to modulate the amplitude of the output.

15. INT CARRIER - This switch determines the source of the modulating signal. When pressed in, the internal 400 Hz oscillator is selected. The signal supplied on the INT-EXT connector (16) is the source of modulation when this switch is pulled out.

16. INT-EXT - An external modulation signal can be applied to this input. The output will be either AM or FM modulated depending on the setting of the MODULATION SELECT switch (14).

## OPERATING INSTRUCTIONS

**WARNING:** Before applying power to your 8102/8105, make sure that the AC input voltage setting (S401) is correctly set for your power source.

1. Connect the 8102/8105 to an AC power source and press the POWER ON switch (1).
2. Select the desired waveform using the FUNCTION select switch (3). To generate a ramp or pulse output, pull out the DUTY CYCLE adjust knob (10) and set to the desired duty cycle.
3. Set the desired frequency with the FREQUENCY CONTROL dial (4) and the RANGE switch (5). The actual output frequency will be:

$$F (\text{out}) = \text{Dial Indication} \times \text{Range setting}$$

4. If the output needs to be less than 20 volts peak to peak, it may be adjusted with the AMPLITUDE control (8) to the desired level. If a very small signal is required, the ATTENUATION switch (7) can be depressed.
5. Any required DC offset voltage can be set with the DC OFFSET (9) control.
6. If a TTL compatible signal is required, use the SYNC output terminal (12).

7. A 180 degree phase shift may be introduced by depressing the **INVERT** switch (6).

8. If minor external control of the outoput frequency is required, you may suppl a trim voltage (< 10 VDC) to the **VCF IN** terminal (13).

9. When AM or FM modulation of the output is desired (Model: 8105 only), the modulation signal should be applied to the **INT-EXT** input (16). **NOTE:** The internal/external **MODULATION** control (15) must be pulled out before any external modulating signal will have an affect. The level of modulation may be adjusted with this control also. If the switch is pressed in, an adjustable level 400 Hz modulation signal is applied to the output.

## OPERATING CAUTIONS

Please observe the following when operating your Model: 8102/8105 Function Generator:

1. To assure operation within the listed specifications, allow the unit to warm up and stabilize for at least 20 minutes.
2. Do not supply more than 10 volts AC or DC into:

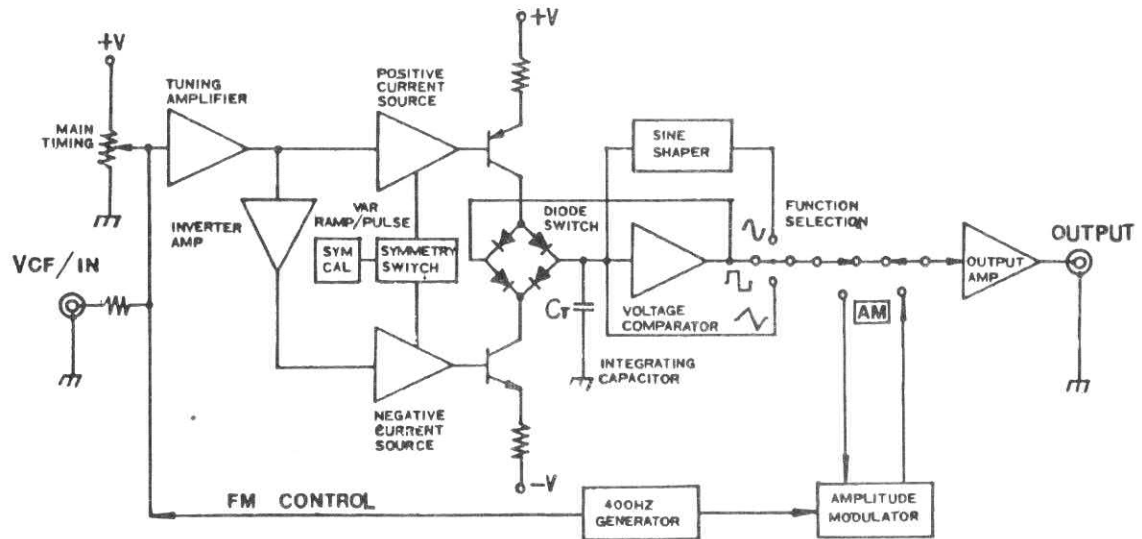
Output terminal (1)

SYNC terminal (12)

VCF IN terminal (13)

INT-EXT terminal (16) (Model: 8105 only)

# BLOCK DIAGRAM



## MAINTENANCE & CALIBRATION

To assure the most stable operation possible, your Model: 8102/8105 should be periodically adjusted. To perform the following adjustment procedures, you will need a philips screwdriver, voltmeter, an oscilloscope (5 MHz minimum), frequency counter, and a distortion meter. As you perform this procedure, please refer to the adjustment position layout drawing.

1. Open the unit by turning it upside down and removing the 4 screws that hold the two halves of the case together.
2. With a voltmeter connected to pin 4 of U101, adjust R410 for  $-15 \text{ VDC} \pm 3\%$ .
3. Connect a frequency counter to the OUTPUT (11) and set the RANGE switch (5) to 10 KHz. Verify that the frequency can be adjusted from 1 KHz to 20 KHz by turning the FREQUENCY CONTROL (2) dial.
4. Connect an oscilloscope to the OUTPUT terminal (11). Set the FUNCTION switch (3) to triangle and set the frequency to 1 KHz. Adjust R130 and R131 until the output signal is balanced both above and below ground.
5. Set the FUNCTION switch (3) to sine wave and connect a distortion meter to the OUTPUT terminal (11). Alternately adjust R237 and R238 for minimum

distortion at 400 Hz and 1 KHz.

6. Set the RANGE switch (5) to 10 KHz and the FREQUENCY CONTROL dial (4) to 2.0. Adjust R129 for an output frequency of 20 KHz.

7. Due to the interaction of the controls, you should repeat steps 3 through 6 above until no further adjustment is necessary at 1 KHz.

8. Set the RANGE switch (5) and the FREQUENCY CONTROL dial (4) to indicate 2MHz. Adjust C106 for a 2 MHz output.

9. Set the AMPLITUDE control (8) to maximum and adjust R240 for 20Vp-p when set for a sine wave output. Select the square wave function and adjust R306 for a 20Vp-p output.

10. Set the AMPLITUDE control (8) to maximum and push in the DC OFFSET control knob (9) (i.e., no offset). Adjust R307 for 0 volts DC offset when generating a sine wave.

11. Select the square wave output and adjust R239 for a DC offset of zero volts.

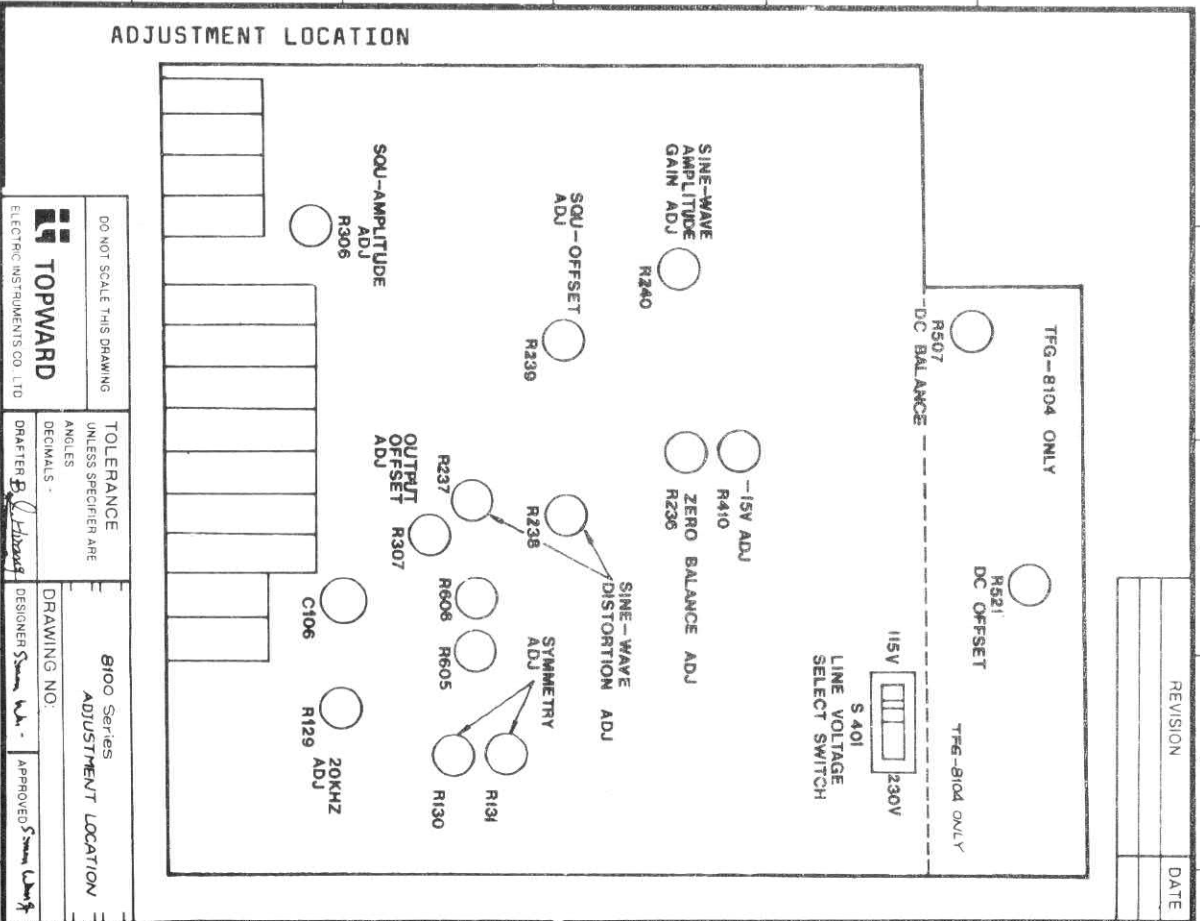
NOTE: The following adjustments only apply to the Model: 8105




12. Set the **MODULATION** switch (14) to AM and press in the switch to select internal modulation. Set the frequency to 100 KHz and the Amplitude to maximum. Adjust R507 until the 400 Hz signal being output at the **INT-EXT** connector (16) is at its maximum level.

13. Connect the oscilloscope to the **OUTPUT** connector (11) and adjust the modulation depth to 100%. Adjust R521 until there is no DC offset of the modulated signal.

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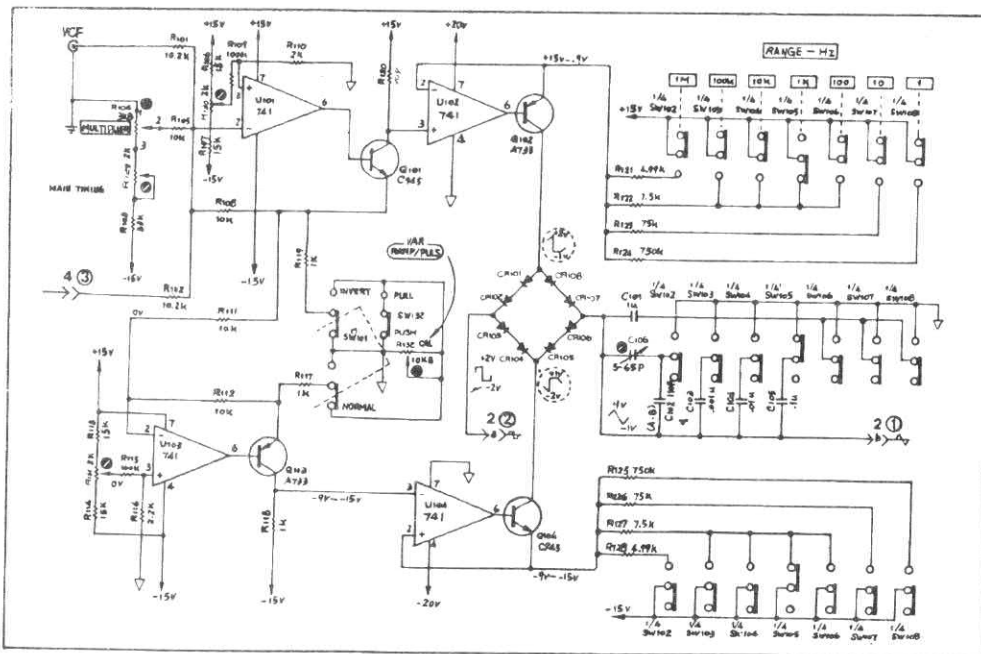
ADJUSTMENT LOCATION

 <b>TOPWARD</b> ELECTRIC INSTRUMENTS CO. LTD.	DO NOT SCALE THIS DRAWING	TOLERANCE UNLESS SPECIFIED ARE ANGLES -	DRAWING NO.
	DRAFTER <i>P. Hayward</i> DESIGNER <i>Simon Webb</i> APPROVED <i>Simon Webb</i>	B100 Series ADJUSTMENT LOCATION	DECIMALS -

# CIRCUIT DIAGRAM

REVISION

DATE



- NOTES: 1. ALL RESISTOR VALUES ARE IN OHMS UNLESS MARKED OTHERWISE IN KILLOHMS (K) OR MEGOHMS (M).  
 2. ALL CAPACITOR VALUES ARE IN MICROFARADS.  
 3. ⚡ DENOTE ANALOG GROUND  
 4. ⊕ DENOTE EARTH GROUND  
 5. Ⓜ DENOTE FRONT PANEL CONTROL  
 6. Ⓢ DENOTE INTERNAL ADJUST

DO NOT SCALE THIS DRAWING



TOLERANCE  
 UNLESS SPECIFIER ARE  
 ANGLES  
 DECIMALS

DRAWN BY *B. J. Young*

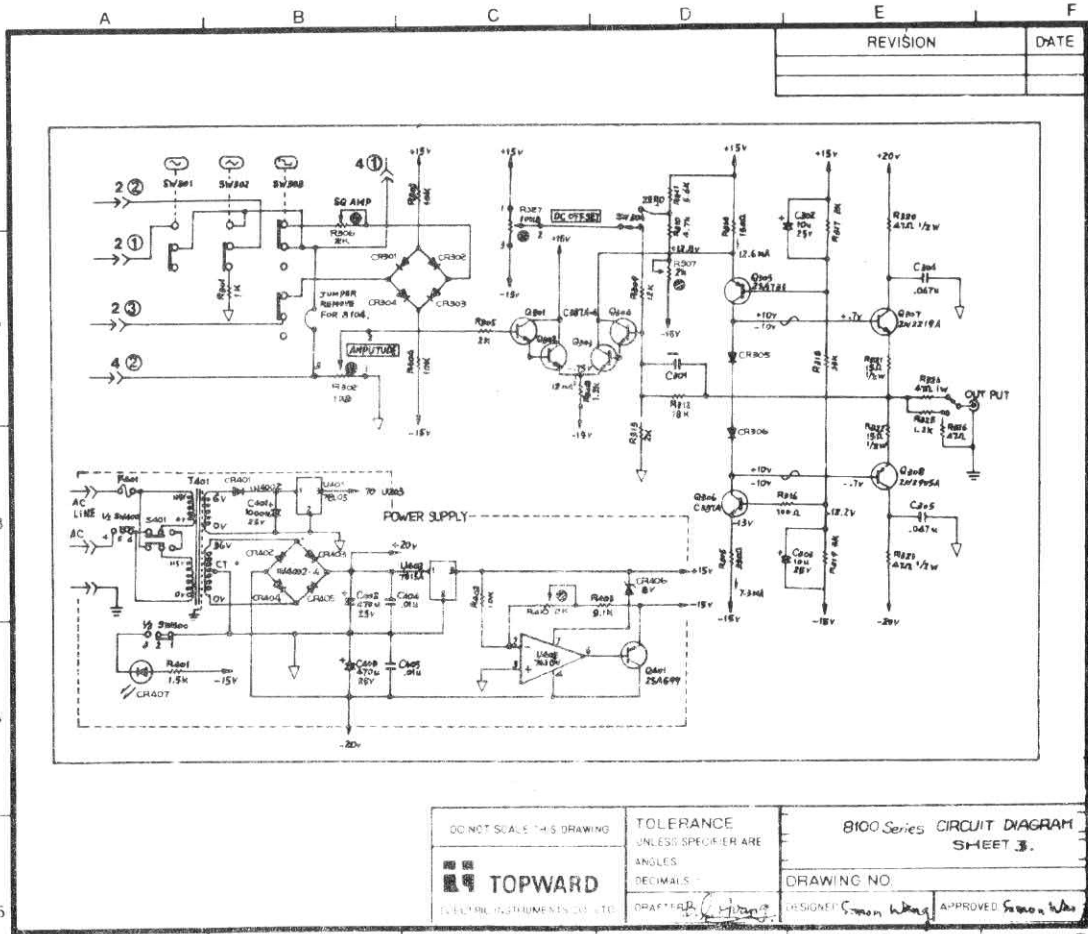
3100 Series CIRCUIT DIAGRAM  
 SHEET 1.

DRAWING NO:

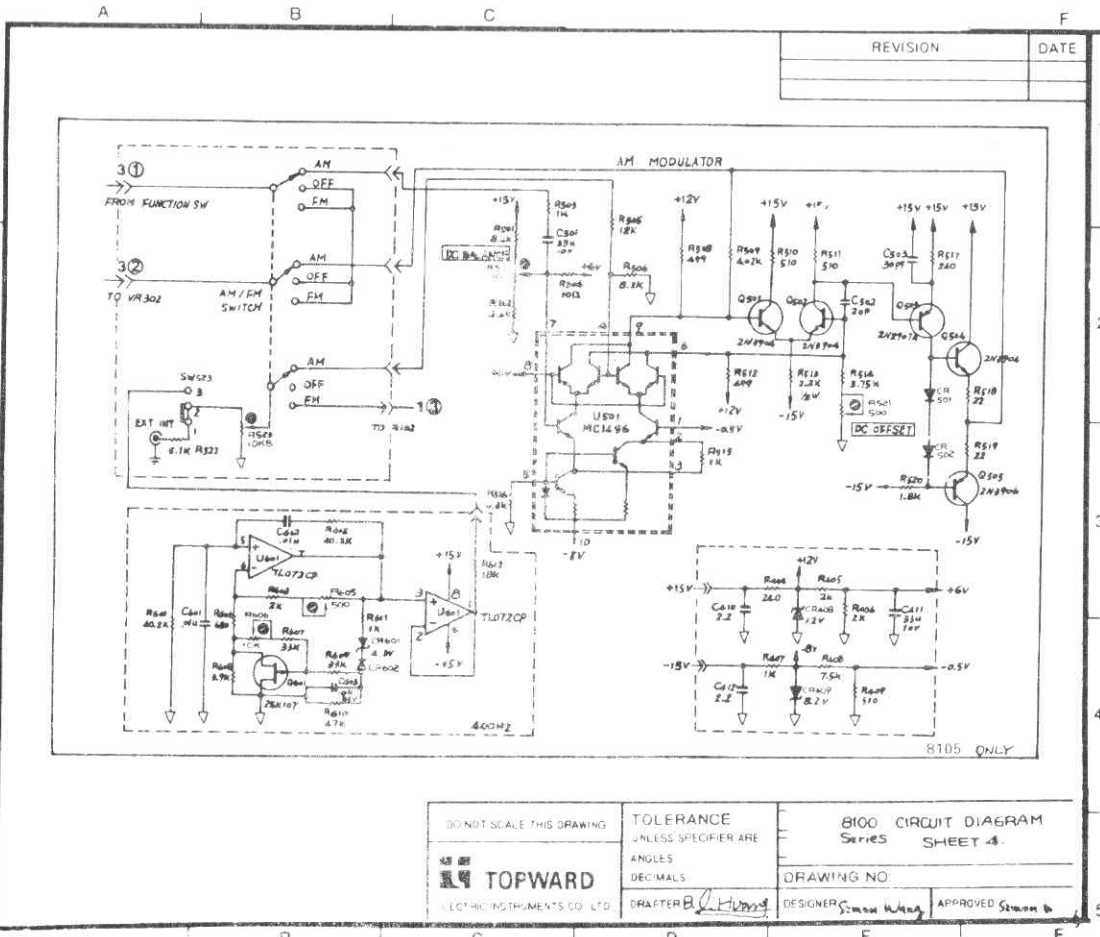
DESIGNER *Steven Wilson*

APPROVED *Steven Wilson*



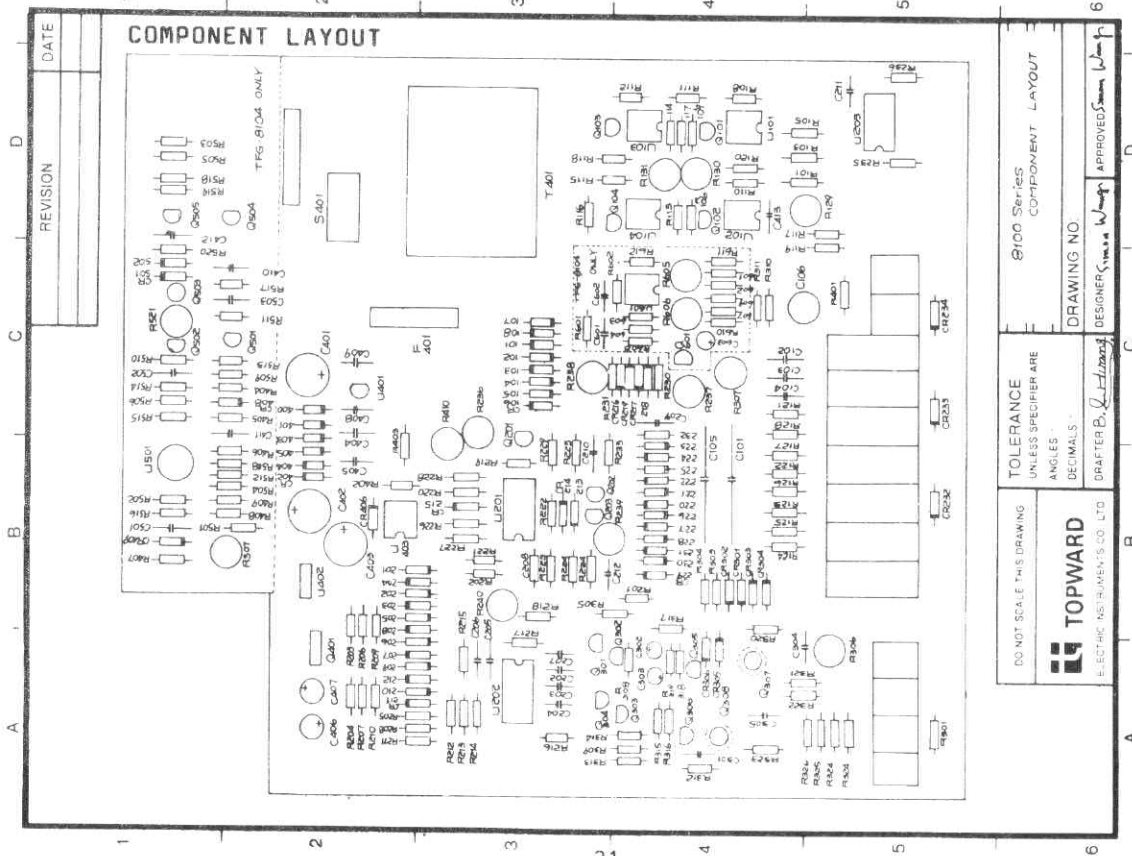


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DONOT SCALE THIS DRAWING TOPWARD ELECTRONIC INSTRUMENTS CO. LTD	TOLERANCE UNLESS SPECIFIER ARE ANGLES DECIMALS DRAFTER <i>B. H. Wong</i>	8100 CIRCUIT DIAGRAM Series SHEET 4
		DRAWING NO. DESIGNER <i>S. M. Wang</i>
APPROVED <i>S. M. Wang</i>		8105 ONLY



REVISION	DATE

### COMPONENT LAYOUT

<p><b>TOPWARD</b> ELECTRIC INSTRUMENTS CO. LTD</p>	<p>DO NOT SCALE THIS DRAWING UNLESS SPECIFIER ARE ANGLES DECIMALS</p>	<p>8100 Series COMPONENT LAYOUT</p>
	<p>DRAWING NO DESIGNER <i>James W. Long</i> DRAFTER <i>B. J. H. Long</i></p>	<p>APPROVED <i>James W. Long</i></p>

## SPECIFICATIONS

Waveforms: Sine, Square, Triangle, Pulse, Ramp  
Frequency: 0.1 Hz - 2.0 MHz in 7 Ranges  
Scale Error:  $\pm 5\%$  of full scale (after 20 minute warm-up)  
Output Impedance:  $50\Omega \pm 10\%$   
Output Level: 5mVp-p (min.) to 20Vp-p (max.) Continuously variable (open circuit)  
Attenuator: 0dB, -30dB  
DC Level:  $\pm 10$  volts (open circuit), continuously variable  
Duty Cycle: 20% - 80% Continuously variable with 50% calibrated switch  
Distortion: THD from 10Hz to 50KHz (of sine wave)  $< 1\%$   
Rise Time:  $< 100\text{nS}$   
Pulse: TTL compatible.  $> 3\text{Vp-p}$  (open circuit).  $T_r < 25\text{nS}$  with 20 TTL loads.  
VCF in: 0 - 5 Vdc. 1000:1 sweep range

(The following specifications apply to Model TFG-8104 only)

### AM Modulation

Depth: 0 - 100%  
Frequency: 400Hz (Internal) DC - 1MHz (External)  
Carrier Bandwidth: 100Hz - 1MHz (3 dB)  
Ext. Sensitivity:  $< 5\text{Vp-p}$  for 100% Modulation



FM Modulation

Deviation:

$0 \pm 10\%$

Modulation Freq:

400Hz  $\pm 10\%$  (Internal) DC - 20KHz (External)

Power:

115/230Vrms  $\pm 10\%$ , 50-60Hz 9.6VA (Approx.)

Sine & Weight:

251(W) $\times$ 92(H) $\times$ 288(D)/1.6Kg.

Accessories:

Test Lead - ACS-003 BNC to Alligator Clip Cable

## PARTS LIST

DESIGNATION	DESCRIPTION	
(600045001)		
C 101	CAP	MF 1UF 100V +-1%
C 102	CAP	PE 100PF 100V +-10%
C 103	CAP	PE 950PF 50V +-10%
C 104	CAP	MF .01UF 100V +-1%
C 105	CAP	MF .1UF 100V +-1%
C 106	CAP	CER SVC 5P-65P +-10%
C 202	CAP	CER .01UF 50V +-10%
C 203	CAP	CER 8PF 50V +-10%
C 204	CAP	CER 12PF 50V +-10%
C 205	CAP	CER 47PF 50V +-10%
C 206	CAP	CER 5PF 50V +-10%
C 207	CAP	CER .01UF 50V +-10%
C 208	CAP	CER 62PF 50V +-10%
C 209	CAP	MYLAR .047UF 100V +-10%
C 210	CAP	MYLAR .068UF 100V +-10%
C 211	CAP	CER .01UF 50V +-10%
C 212	CAP	MYLAR .068UF 100V +-10%
C 302	CAP	ELEC 10UF 25V +80%-20%
C 303	CAP	ELEC 10UF 25V +80%-20%
C 304	CAP	MYLAR .047UF 100V +-10%
C 305	CAP	MYLAR .047UF 100V +-10%
C 401	CAP	ELEC 1000UF 25V +80%-20%

DESIGNATION		DESCRIPTION				
C	402	CAP	ELEC	1000UF	25V	+80%-20%
C	403	CAP	ELEC	1000UF	25V	+80%-20%
C	404	CAP	CER	.01UF	50V	+/-10%
C	405	CAP	CER	.01UF	50V	+/-10%
C	406	CAP	ELEC	220UF	25V	+80%-20%
C	407	CAP	ELEC	220UF	25V	+80%-20%
C	408	CAP	CER	.01UF	50V	+/-10%
C	409	CAP	CER	.01UF	50V	+/-10%
C	*410	CAP	ELEC	2.2UF	35V	+80%-20%
C	*411	CAP	ELEC	33UF	10V	+80%-20%
C	*412	CAP	ELEC	2.2UF	35V	+80%-20%
C	413	CAP	CER	.01UF	50V	+/-10%
C	*501	CAP	ELEC	33UF	10V	+80%-20%
C	*502	CAP	CER NPO	20PF	50V	+/-10%
C	*503	CAP	CER NPO	33PF	50V	+/-10%
C	*601	CAP	MYLAR	.01UF	50V	+/-5%
C	*602	CAP	MYLAR	.01UF	50V	+/-5%
C	*603	CAP	ELEC	10UF	50V	+80%-20%
CR	101	DIODE	1S953	50mA	35V	3nS
CR	102	DIODE	1S953	50mA	35V	3nS
CR	103	DIODE	1S953	50mA	35V	3nS
CR	104	DIODE	1S953	50mA	35V	3nS

DESIGNATION	DESCRIPTION
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CR 105	DIODE 1S953 50mA 35V 3nS
CR 106	DIODE 1S953 50mA 35V 3nS
CR 107	DIODE 1S953 50mA 35V 3nS
CR 108	DIODE 1S953 50mA 35V 3nS
CR 201	DIODE 1S953 50mA 35V 3nS
CR 202	DIODE 1S953 50mA 35V 3nS
CR 203	DIODE 1S953 50mA 35V 3nS
CR 204	DIODE 1S953 50mA 35V 3nS
CR 205	DIODE 1S953 50mA 35V 3nS
CR 206	DIODE 1S953 50mA 35V 3nS
CR 207	DIODE 1S953 50mA 35V 3nS
CR 208	DIODE 1S953 50mA 35V 3nS
CR 209	DIODE 1S953 50mA 35V 3nS
CR 210	DIODE 1S953 50mA 35V 3nS
CR 211	DIODE 1S953 50mA 35V 3nS
CR 212	DIODE 1S953 50mA 35V 3nS
CR 213	DIODE 1S953 50mA 35V 3nS
CR 214	DIODE 1S953 50mA 35V 3nS
CR 215	DIODE 1S953 50mA 35V 3nS
CR 216	DIODE 1S953 50mA 35V 3nS
CR 217	DIODE 1S953 50mA 35V 3nS
CR 218	DIODE 1S953 50mA 35V 3nS
CR 219	DIODE 1S953 50mA 35V 3nS

DESIGNATION	DESCRIPTION
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CR 220	DIODE 1S953 50mA 35V 3nS
CR 221	DIODE 1S953 50mA 35V 3nS
CR 222	DIODE 1S953 50mA 35V 3nS
CR 223	DIODE 1S953 50mA 35V 3nS
CR 224	DIODE 1S953 50mA 35V 3nS
CR 225	DIODE 1S953 50mA 35V 3nS
CR 226	DIODE 1S953 50mA 35V 3nS
CR 227	DIODE 1S953 50mA 35V 3nS
CR 228	DIODE 1S953 50mA 35V 3nS
CR 229	DIODE 1S953 50mA 35V 3nS
CR 230	DIODE 1S953 50mA 35V 3nS
CR 231	DIODE 1S953 50mA 35V 3nS
CR 232	DIODE 1S953 50mA 35V 3nS
CR 233	DIODE 1S953 50mA 35V 3nS
CR 234	DIODE 1S953 50mA 35V 3nS
CR 301	DIODE 1S953 50mA 35V 3nS
CR 302	DIODE 1S953 50mA 35V 3nS
CR 303	DIODE 1S953 50mA 35V 3nS
CR 304	DIODE 1S953 50mA 35V 3nS
CR 305	DIODE 1S953 50mA 35V 3nS
CR 306	DIODE 1S953 50mA 35V 3nS
CR 401	DIODE 1N4002 100V 1A
CR 402	DIODE 1N4002 100V 1A

DESIGNATION	DESCRIPTION
CR 403	DIODE 1N4002 100V 1A
CR 404	DIODE 1N4002 100V 1A
CR 405	DIODE 1N4002 100V 1A
CR 406	ZENER DIODE 8.5V 1/2W
CR 407	LED 3.0Ø RED ROUND
CR *408	ZENER DIODE 12V
CR *409	ZENER DIODE 8.2V
CR *501	DIODE 1S953 50mA 35V 3nS
CR *502	DIODE 1S953 50mA 35V 3nS
CR *601	ZENER DIODE 4.3V
CR *602	DIODE 1S953 50mA 35V 3nS
Q 101	TRANS 2SC945
Q 102	TRANS A733
Q 103	TRANS A733
Q 104	TRANS 2SC945
Q 201	TRANS 2N5458 (FET)
Q 202	TRANS A733
Q 203	TRANS A733
Q 301	TRANS C1674
Q 302	TRANS C1674
Q 303	TRANS C1674
Q 304	TRANS C1674

## DESIGNATION

## DESCRIPTION

Q	305	TRANS.	A733		
Q	306	TRANS	C1674		
Q	307	TRANS	2N2219A		
Q	308	TRANS	2N2905A		
Q	401	TRANS	2SA699A		
Q	*501	TRANS	2N3904		
Q	*502	TRANS	2N3904		
Q	*503	TRANS	2N2907A		
Q	*504	TRANS	2N3904		
Q	*505	TRANS	2N3906		
Q	*601	TRANS	2SK107 (FET)		
R	101	RES	MF	10.2K	+ -1% 1/4W
R	102	RES	MF	10.2K	+ -1% 1/4W
R	103	RES	CARBON	3.3K	+ -5% 1/4W
R	104	RES	VR 3KB	+ -10%	
R	105	RES	MF	10K	+ -1% 1/4W
R	106	RES	CARBON	15K	+ -5% 1/4W
R	107	RES	CARBON	15K	+ -5% 1/4W
R	108	RES	MF	10K	+ -1% 1/4W
R	109	RES	CARBON	100K	+ -5% 1/4W
R	110	RES	CARBON	2K	+ -5% 1/4W
R	111	RES	MF	10K	+ -1% 1/4W

## DESIGNATION

## DESCRIPTION

R	112	RES	MF	10K		+ -1%	1/4W
R	113	RES	CARBON	15K		+ -5%	1/4W
R	114	RES	CARBON	15K		+ -5%	1/4W
R	115	RES	CARBON	100K		+ -5%	1/4W
R	116	RES	CARBON	2.2K		+ -5%	1/4W
R	117	RES	MF	1K		+ -1%	1/4W
R	118	RES	MF	1K		+ -1%	1/4W
R	119	RES	MF	1K		+ -1%	1/4W
R	120	RES	MF	909	OHM	+ -1%	1/4W
R	121	RES	MF	4.99K		+ -1%	1/4W
R	122	RES	MF	7.5K		+ -1%	1/4W
R	123	RES	MF	75K		+ -1%	1/4W
R	124	RES	MF	750K		+ -1%	1/4W
R	125	RES	MF	750K		+ -1%	1/4W
R	126	RES	MF	75K		+ -1%	1/4W
R	127	RES	MF	7.5K		+ -1%	1/4W
R	128	RES	MF	4.99K		+ -1%	1/4W
R	129	RES	SVR	2K		+ -10%	
R	130	RES	SVR	2K		+ -10%	
R	131	RES	SVR	2K		+ -10%	
R	132	RES	VR	10KB		+ -10%	2PORT
R	201	RES	CARBON	200	OHM	+ -5%	1/4W
R	202	RES	CARBON	47	OHM	+ -5%	1/2W



## DESIGNATION

## DESCRIPTION

R	203	RES	MF	12K		+ -1%	1/4W
R	204	RES	MF	12K		+ -1%	1/4W
R	205	RES	CARBON	300	OHM	+ -5%	1/4W
R	206	RES	MF	15K		+ -1%	1/4W
R	207	RES	MF	15K		+ -1%	1/4W
R	208	RES	CARBON	200	OHM	+ -5%	1/4W
R	209	RES	MF	27K		+ -1%	1/4W
R	210	RES	MF	27K		+ -1%	1/4W
R	211	RES	CARBON	120	OHM	+ -5%	1/4W
R	212	RES	CARBON	68	OHM	+ -5%	1/4W
R	213	RES	CARBON	1K		+ -5%	1/4W
R	214	RES	CARBON	1K		+ -5%	1/4W
R	215	RES	CARBON	3.9K		+ -5%	1/4W
R	216	RES	CARBON	680	OHM	+ -5%	1/4W
R	217	RES	CARBON	150	OHM	+ -5%	1/4W
R	218	RES	CARBON	6.8K		+ -5%	1/4W
R	219	RES	CARBON	6.8K		+ -5%	1/4W
R	220	RES	CARBON	1K		+ -5%	1/4W
R	221	RES	CARBON	2.7K		+ -5%	1/4W
R	222	RES	CARBON	1K		+ -5%	1/4W
R	223	RES	CARBON	1.2K		+ -5%	1/4W
R	224	RES	CARBON	3.2K		+ -5%	1/4W
R	225	RES	CARBON	8.2K		+ -5%	1/4W

## DESIGNATION

## DESCRIPTION

R	226	RES	CARBON	3.9K	+ -5%	1/4W
R	227	RES	CARBON	33K	+ -5%	1/4W
R	228	RES	CARBON	6.8K	+ -5%	1/4W
R	229	RES	CARBON	330 OHM	+ -5%	1/4W
R	230	RES	CARBON	10K	+ -5%	1/4W
R	231	RES	CARBON	10K	+ -5%	1/4W
R	232	RES	CARBON	2.7K	+ -5%	1/4W
R	233	RES	CARBON	910 OHM	+ -5%	1/4W
R	234	RES	CARBON	1.5K	+ -5%	1/4W
R	235	RES	CARBON	6.8K	+ -5%	1/4W
R	236	RES	SVR 2K	+ -10%		
R	237	RES	SVR 2K	+ -10%		
R	238	RES	SVR 2K	+ -10%		
R	239	RES	SVR 2K	+ -10%		
R	240	RES	SVR 2K	+ -10%		
R	301	RES	CARBON	1K	+ -5%	1/4W
R	302	RES	VR 1KB	+ -10%		
R	303	RES	CARBON	10K	+ -5%	1/4W
R	304	RES	CARBON	10K	+ -5%	1/4W
R	305	RES	CARBON	2K	+ -5%	1/4W
R	306	RES	SVR 2K	+ -10%		
R	307	RES	SVR 2K	+ -10%		
R	308	RES	CARBON	680 OHM	+ -5%	1/2W

## DESIGNATION

## DESCRIPTION

R	309	RES	CARBON	12K	+ -5%	1/4W
R	310	RES	CARBON	4.7K	+ -5%	1/4W
R	311	RES	CARBON	5.6K	+ -5%	1/4W
R	312	RES	CARBON	18K	+ -5%	1/4W
R	313	RES	MF	1.54K	+ -1%	1/4W
R	314	RES	CARBON	120	OHM + -5%	1/4W
R	315	RES	CARBON	200	OHM + -5%	1/2W
R	316	RES	CARBON	100	OHM + -5%	1/4W
R	317	RES	CARBON	3K	+ -5%	1/4W
R	318	RES	CARBON	33K	+ -5%	1/4W
R	319	RES	CARBON	3K	+ -5%	1/4W
R	320	RES	CARBON	47	OHM + -5%	1/2W
R	321	RES	CARBON	15	OHM + -5%	1/2W
R	322	RES	CARBON	15	OHM + -5%	1/2W
R	323	RES	CARBON	47	OHM + -5%	1/2W
R	324	RES	CARBON	100	OHM + -5%	1/2W
R	325	RES	CARBON	1.2K	+ -5%	1/2W
R	326	RES	CARBON	47	OHM + -5%	1/2W
R	327	RES	VR 10KB	+ -10%	2PORT	
R	401	RES	CARBON	1.5K	+ -5%	1/4W
R	402	RES	CARBON	10K	+ -5%	1/4W
R	403	RES	CARBON	9.1K	+ -5%	1/4W
R	*404	RES	CARBON	240	OHM + -5%	1/4W

## DESIGNATION

## DESCRIPTION

R	*405	RES	CARBON	2K	+ -5%	1/4W
R	*406	RES	CARBON	2K	+ -5%	1/4W
R	*407	RES	CARBON	1K	+ -5%	1/4W
R	*408	RES	CARBON	7.5K	+ -5%	1/4W
R	*409	RES	CARBON	510 OHM	+ -5%	1/4W
R	410	RES	SVR	2K	+ -10%	
R	*501	RES	CARBON	8.2K	+ -5%	1/4W
R	*502	RES	CARBON	3.6K	+ -5%	1/4W
R	*503	RES	MF	1K	+ -1%	1/4W
R	*504	RES	MF	10 OHM	+ -1%	1/4W
R	*505	RES	CARBON	12K	+ -5%	1/4W
R	*506	RES	CARBON	8.2K	+ -5%	1/4W
R	*507	RES	SVR	10K	+ -10%	
R	*508	RES	MF	499 OHM	+ -1%	1/4W
R	*509	RES	MF	4.02K	+ -1%	1/4W
R	*510	RES	CARBON	510 OHM	+ -5%	1/4W
R	*511	RES	CARBON	510 OHM	+ -5%	1/4W
R	*512	RES	MF	499 OHM	+ -1%	1/4W
R	*513	RES	CARBON	2.2K	+ -5%	1/4W
R	*514	RES	MF	3.75K	+ -1%	1/4W
R	*515	RES	MF	1K	+ -1%	1/4W
R	*516	RES	CARBON	6.8K	+ -5%	1/4W
R	*517	RES	CARBON	240 OHM	+ -5%	1/4W

## DESIGNATION

## DESCRIPTION

R	*518	RES	CARBON	22	OHM	+ -5%	1/4W
R	*519	RES	CARBON	22	OHM	+ -5%	1/4W
R	*520	RES	CARBON	1.8K		+ -5%	1/4W
R	*521	RES	SVR	500	OHM	+ -10%	
R	*522	RES	CARBON	5.1K		+ -5%	1/4W
R	*523	RES	VR	10KB		+ -10%	2PORT
R	*601	RES	MF	40.2K		+ -1%	1/4W
R	*602	RES	MF	40.2K		+ -1%	1/4W
R	603	RES	CARBON	2K		+ -5%	1/4W
R	*604	RES	CARBON	680	OHM	+ -5%	1/4W
R	*605	RES	SVR	500	OHM	+ -10%	
R	*606	RES	SVR	10K		+ -10%	
R	*607	RES	CARBON	33K		+ -5%	1/4W
R	*608	RES	CARBON	3.9K		+ -5%	1/4W
R	*609	RES	CARBON	33K		+ -5%	1/4W
R	*610	RES	CARBON	47K		+ -5%	1/4W
R	*611	RES	MF	1K		+ -1%	1/4W
R	*612	RES	CARBON	18K		+ -5%	1/4W
U	101	IC	UA741CP				
U	102	IC	UA741CP				
U	103	IC	UA741CP				
U	104	IC	UA741CP				

DESIGNATION	DESCRIPTION
U 201	IC CA3086
U 202	IC CA3030
U 203	IC SN7420
U 401	IC 78L05
U 402	IC 7815
U 403	IC UA741CP
U *501	IC MC1496
U *601	IC TL072CP
F 401	FUSE 0.5A
S 401	SLIDE SWITCH 115V/230V PCB-TYPE
T 401	TRANSFORMER

1 PUSH SWITCH  
 1 POWER AC CORD  
 2 FUSE HOUSING  
 3 BNC  
 1 HOUSING 22Ø 42mm  
 2 HEAT SINK U-TYPE  
 2 HEAT SINK \*-TYPE  
 4 KNOB IVORY  
 1 KNOB RED  
 8 KNOB GRAY

DESIGNATION	DESCRIPTION
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1	CONNECTOR 2PIN PITCH=2.54mm L=50mm
1	CONNECTOR 2PIN PITCH=2.54mm L=80mm
1	CONNECTOR 2PIN PITCH=2.54mm L=160mm
1	CONNECTOR 2PIN PITCH=2.54mm L=250mm
1	CONNECTOR 2PIN PITCH=2.54mm L=80mm
1	CONNECTOR 4PIN PITCH=2.54mm L=200mm
1	CONNECTOR 6PIN PITCH=2.54mm
1	CONNECTOR 3PIN PITCH=3.96mm L=170mm
1	CONNECTOR 2PIN PITCH=3.96mm L=180mm
*	1 CONNECTOR 2PIN PITCH=2.54mm L=250mm
*	1 CONNECTOR 3PIN PITCH=2.54mm L=260mm
*	1 BNC
*	2 KNOB PN-37 BLACK
	3 KNOB PN-37 BLACK
	1 KNOB PN-37 BLACK
	1 SCALPE PLATE ACRYLIC T=2.5mm
*	1 ROTARY SW 1-3-3

NOTE: " \* " is 8105 only