FUNCTION GENERATOR

GF-232

1 GENERAL

1.1 Description

The remarkable versatility of the GF-232 Function Generator is a result of its unique features:

- A wide frequency range: 0.2 Hz - 2 MHz makes it possible for the user to analyze even very low frequencies.

- It generates three basic output signals: sinusoidal, triangular and square, as well as positive pulses compatible with TTL circuits, with a fixed output, independent of the main signal frequency.

- It is equipped with a digital indicator of the frequency bands from 20 Hz to 2 MHz for a more accurate reading of the values generated in each instance.

- It is equipped with three auxiliary functions:

  - Frequency counter of up to 10 MHz
  - Power amplifier of up to 4 MHz and an output impedance of 50 Ω.
  - Variable level comparator

These functions are explained further on.

The instrument has two additional important features: an input for the external control of the frequency or its modulation and a control to add a continuous voltage of the desired polarity to the signal.

Another factor that should not be overlooked is its ease of use. In addition, its functional design facilitates maintenance substantially.

1.2 Information on the standards and regulations

This instrument has been designed in compliance with the EN55011 standards on radio interference and the HD401S1 safety standard.

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1.3 Specifications

Frequency range	0.2 Hz to 2 MHz in 7 decades
Frequency control	
Continuous variation control	Ratio 10:1
	Accuracy ± 5%
Frequency indicator	Digital (20 Hz to 2 MHz)
Accuracy	± 1 digit
Resolution	0.1 Hz to 1 kHz
Time between readings (counting time)	
	250 ms
External control by voltage (VCO/FM)	Control voltage 10 V
	For a 10:1 variation
	Linear variation
	Input impedance 15 kΩ
50 Ω OUTPUT	
Output signals	Sinusoidal, triangular, square, positive and negative pulses, variable symmetry.
	Selectables.
Symmetry control	10:1 continuously variable on both senses.
Output amplitude	20 Vpp (open circuit)
	10 Vpp (50 Ω)
Output impedance	50 Ω
Amplitude control	
Continuously variable	> 30 dB
Attenuator	20 dB
DC offset	Continuously variable
	± 10 V (open circuit)
	± 5 V (50 Ω)
Output voltage without clipping	± 10 V (open circuit)
	$V_{offset} + V_p = \pm 10$ V max.
Sinusoidal	
Amplitude response	- 1 dB at the nominal output (50 Ω)
	Ref. 10 kHz
Distortion	< 0.6% at the nominal output (up to 100 kHz, 50 Ω).
Triangular	Linearity < 1%
Square	Rise time < 80 ns
	Typical 50 ns
TTL OUTPUT	
Amplitude	> 3 V (open circuit)
	Independent of the main output
Symmetry	Continuously variable
Rise time	< 25 ns

EXTERNAL FREQUENCY COUNTER

Maximum frequency	10 MHz
Resolution	100 Hz
Sensitivity	60 mV (5 MHz)
Input impedance	100 kΩ

AMPLIFIER

Bandwith	4 MHz
Input impedance	100 kΩ
Output impedance	50 Ω
Maximum output amplitude	10 Vpp (50 Ω)
Gain	32 dB [40] (open circuit)

LEVEL COMPARATOR

Input impedance	100 kΩ
Output amplitude	TTL compatible
Trigger control	Variable ± 150 mV

POWER

Mains voltage	110-125-220-230-240 V AC ± 10%, 50-60 Hz.
Power Consumption	14 W

MECHANICAL CHARACTERISTICS

Dimensions (W x H x D)	212 x 102 x 241 mm
Weight	1.7 Kg

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2 INSTALLATION

2.1 Power requirements

This equipment requires a mains power source of 110-125-220 or 230/240 V AC 50 to 60 Hz. Mains operating voltage can be selected at the rear panel.

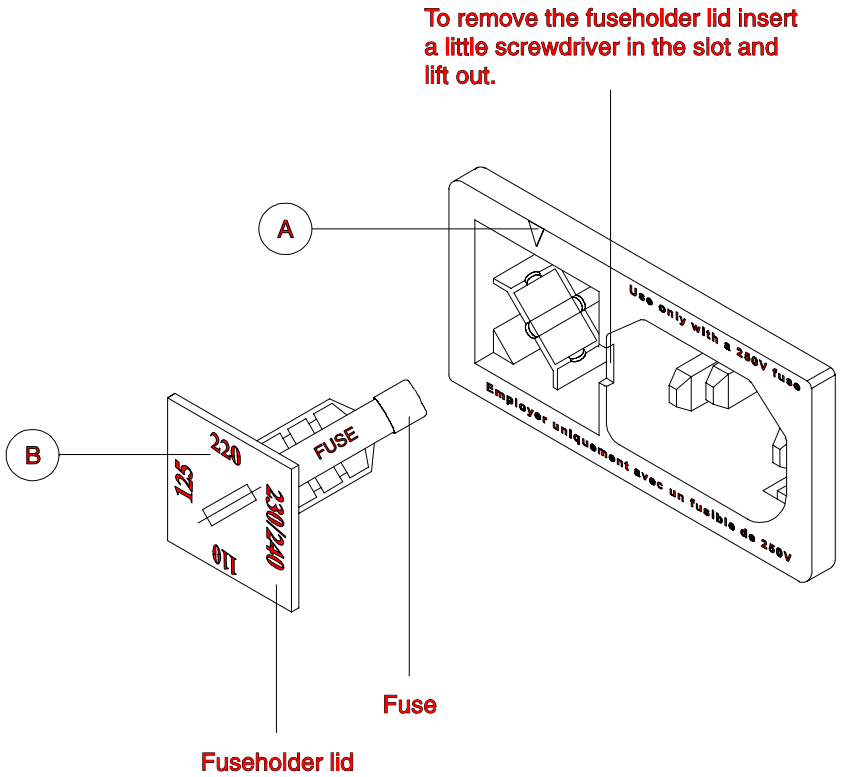

Figure 1.- Selection of mains voltage.

1.- Pull out the fuseholder lid.

2.- Set the proper fuse for the desired mains voltage.

3.- Insert the fuseholder lid so the [**A**] pointer faces the desired mains

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voltage display [**B**].

CAUTION:
THE EQUIPMENT IS FACTORY SET FOR 220 V OPERATING VOLTAGE.

BEFORE SWITCHING ON THIS INSTRUMENT, SET THE VOLTAGE SELECTOR TO THE PROPER POSITION AND BE SURE THAT THE FUSE VALUE IS ACCORDING TO THE MAINS VOLTAGE.

FUSE TYPE SHOULD BE: 5 x 20 mm., 250 V, QUICK ACTING (F). and:

0.25 A FOR 220, 230 and 240 V.
0.50 A FOR 110 and 125 V.

AVOIDING THIS DIRECTIONS COULD DAMAGE THE EQUIPMENT

2.2 Grounding

To ensure complete safety during operation, the GF-232 is equipped with the proper connector on the rear panel for its GROUNDING (Mains connector [19]).

2.3 Installation and start-up

The GF-232 is designed to be used as a desktop instrument.

Once the correct voltage to be used has been selected, the user then connects the instrument to the mains and turns the device on with the corresponding switch.

For operating convenience, a folding stand is supplied for raising the front part of the instrument.

3 OPERATING INSTRUCTIONS

3.1 Description of the controls

Front panel

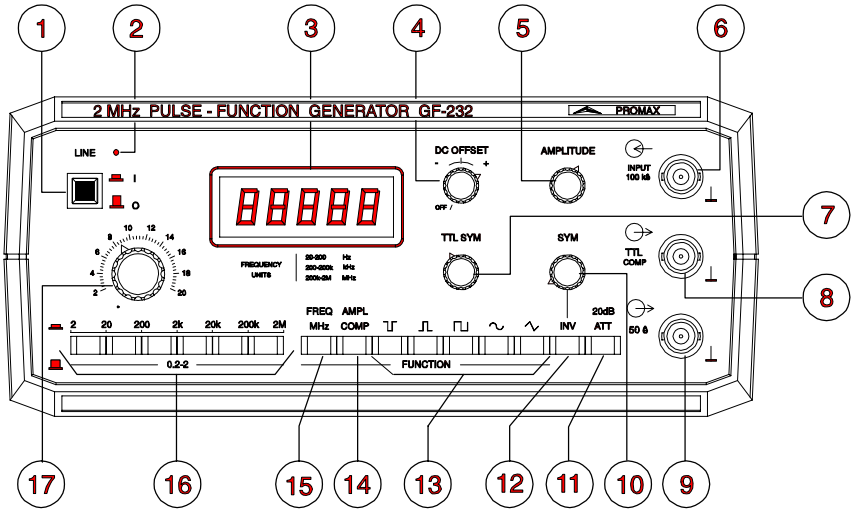

Figure 2.- Front panel.

[1] LINE. The power switch.
In the ON position, the instrument is powered by the mains voltage.

[2] LED. Operating signal.
Indicates that the instrument is in operation.

[3] Frequency indicator.
The display is a five-digit LCD, which indicates the output frequency of the generator or that of the [6] input signal when the frequency counter function is selected.

[4] DC OFFSET. Offset voltage control.
The normal operating position is "off" (as far left as possible). Turning the knob, there is a progressive control of the continuous voltage superimposed on the signal. This voltage ranges from + 10 V to – 10 V (in open circuit), with 0 V as the normal operating position.

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[5] AMPLITUDE. Amplitude control.
A continuously variable control to regulate the output amplitude.

[6] Input for the frequency measurement and it also serves as input in the amplifier and comparator functions.

[7] TTL SYM. TTL symmetry control.
This control enables the user to modify the symmetry of the pulse signal obtained in the [8] TTL output.

[8] Pulse output with TTL levels at the same frequency as the [9] output signal. Allows the charge of more than 10 TTL inputs.

[9] Output of the signal selected by [13], with an internal impedance of 50 Ω.

[10] SYM. Symmetry control.
With this control the user can increase the time corresponding to a half-period of the [9] main signal. In this way, asymmetrical output functions are obtained. The output frequency is thereby modified.

It is possible to select the action on either of the two half-periods.

[11] 20 dB ATT. 20 dB attenuator.
Maintaining the output impedance, it attenuates by 20 dB the output level selected with [5] control.

[12] INV Selector.
This enables the user to select the half-period of the output signal in which the [10] symmetry control acts.

[13] FUNCTION. Output function selectors.
By pressing the selectors, the user can chose the square, triangular and sinusoidal waveforms, positive and negative pulses for output [9].

[14] AMPL/COMP.
This enables the utilization of the equipment as an amplifier or as a level comparator, simultaneously.

For it to function as an amplifier, the user must select the [6] connector as the signal input and the [9] connector as the output. Notice that the [5] amplitude control and the [11] attenuator are operational at all times.

For it to function as a level comparator, the user must select the [6] connector as described above, and the logic level output will be the [8] TTL output. The [7] TTL SYM control enables the user to modify the

comparator level.

[15] FREQ MHz.
When this auxiliary function is activated, the generator will function as a frequency counter, with a use range of up to 10 MHz. In such a case, the [6] connector is used as a signal input and the [3] display as a display element with a resolution of up to five digits.

[16] FREQ. Band selectors.
To chose the frequency range or decade (Hz) that governs control [17]. Each selector has two possible actions when pressed, in the following order:

- Deactivating any other key of the set.
- Setting it in the position pressed.

When any key that has not been pressed is pressed partway in and left in that position, they will all be deactivated. In the "all deactivated" position, the selected frequency band will be 0.2 Hz to 2 Hz.

ATTENTION:
The user must work in an area in which the V_p (the peak voltage of the output signal) plus the offset voltage (displacement) does not exceed ± 10 V in open circuit (± 5 V, 600 Ω), so that clipping does not occur in the output signal.

[17] Frequency control.
Continously variable control of the frequency of the band selected with the [16] control.

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Rear panel

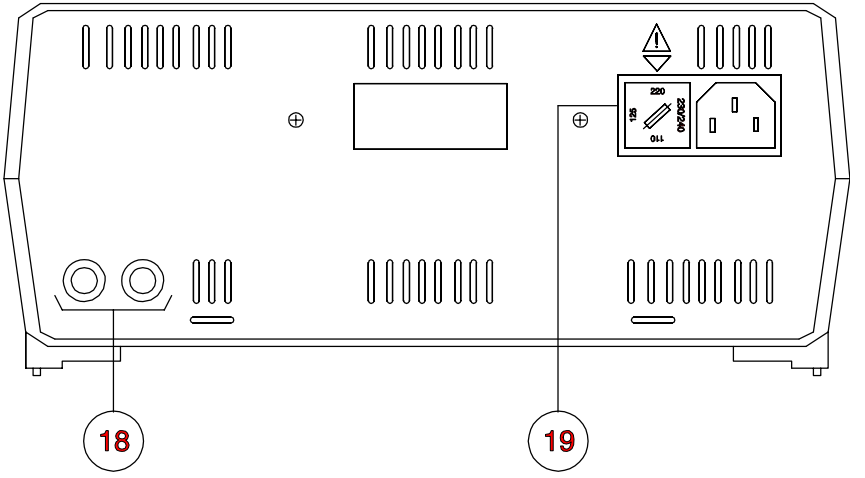

Figure 3.- Rear panel.

[18] VCO. Frequency control by voltage input.
This allows the user to control the output frequency or modulate it in FM in the frequency range selected in [16]. To produce a 10:1 variation, approximately 10 V must be applied. Negative control voltages result in an increase in frequency and vice versa.

[19] Power supply connector, voltage selector and fuse holder.
The power supply lead included among the accessories of the instrument should be connected here AFTER THE VOLTAGE IS SELECTED.

Voltage selector and fuse holder: Depending on the position of the fuse holder clip, the power voltage selected will be 110, 125, 220, or 230/240 V (see Figure 1).

3.2 Modes of operation

3.2.1 Main output

Select the desired function using the [13] controls on the front panel.

Select the frequency using the [16], [17] and [3] controls.

Using an oscilloscope or another suitable instrument, select the desired output amplitude for the low levels of the signal. It may be necessary to use the continuous control and the attenuator.

If it is necessary to superimpose a continuous voltage on the signal, use the [4] DC OFFSET control. In such a case the user must take into account the fact that the oscilloscope used for the measurement has the vertical input direct-coupled (DC).

If the frequency to be studied is lower than approximately 1 Hz, it is best to use an instrument that allows the observation of slow phenomena.

Remember that the optimum transmission of the signal, in the cable connected at the output, is obtained when using a cable with 50 Ω characteristic impedance, with a matching terminal charge.

3.2.2 Frequency selection

In the bands that cover from 20 Hz to 2 MHz, the [3] digital frequency indicator is activated, which enables the fast, accurate selection of the desired frequency, through the [17] frequency control.

If the bands are below 20 Hz, from 0.2 Hz to 2 Hz and from 2 Hz to 20 Hz, the frequency counter is deactivated, and the frequency can be determined directly from the indication on the panel of the [17] frequency control.

When using the [10] variable symmetry control, the frequency lowers as a function of the desired asymmetry. In the bands ranging from 200 Hz to 2 MHz, the frequency reading on the [3] display continues to be valid, while in the 20 Hz to 200 Hz band, the display is deactivated when the [10] SYM control is activated, due to the fact that the frequency can be reduced to lower than 20 Hz. When it is necessary to know the frequency of an asymmetrical signal in the three lowest frequency bands, an external meter must be utilized.

3.2.3 TTL pulse output

If the user wishes to use the pulse output, connect the circuit being tested directly to the [8] output.

The frequency selection here is done in the same way as for the main output. By using the [7] control, it is possible to vary the symmetry of the signal without modifying the repetition frequency at the same time.

3.2.4 The frequency counter

As we have already mentioned above, the GF-232 can be used as a frequency counter with a use range of up to 10 MHz, through the [15] kHz FREQ selector. The device ceases to function as a generator and shows the frequency reading on the display (in kHz), with a resolution of the frequency counter of 100 Hz. If the maximum capacity of the display (99999) is exceeded, two points (:) are activated after the most significant number.

3.2.5 The amplifier

Through the [14] AMPL/COMP selector, the device is converted into an amplifier that covers the range between DC and 4 MHz, with a gain of 32 dB in open circuit. It can be charged with 50 Ω lines and can deliver up to 10 Vpp on this charge.

It is possible to use the continuous amplitude variation control, [5] AMPLITUDE, and to add a DC offset using the [4] DC OFFSET control. In this mode of operation, the maximum excursion of the output is a peak value of ± 10 V, which include the AC and DC components.

The 20 dB attenuator continues to be operational.

3.2.6 The comparator

Through the [14] AMP/COMP selector, the GF-232 operates as a comparator with variable level. The signal input is through the [6] connector, while the TTL level output is obtained through the [8] connector.

The change of state is done through a hysteresis at the input, approximately 70 mV, while the trigger point can be varied with the [7] TTL SYM control between ± 150 mV. The characteristics of the TTL pulse output are also applicable in the threshold comparator function.

This function will be applicable in cases in which the user wants to shape a digital signal or make a analogue signal compatible, with two levels of interest, with a digital system.

3.2.7 External frequency control

To use the external frequency control, the user simply connects the appropiate voltage to the terminals on the rear panel.

If the frequency sweep of a complete decade is necessary, select this with the [16] control on the front panel, and use as a control signal a 10 V ramp that a similar instrument can deliver.

Bear in mind the fact that the variation direction of the frequency is the inverse of the voltage that produces it.

WARNINGS
Do not connect voltage to the instrument output.
Use VCO control voltages that are free of noise and hum.

3.3 Special operating considerations

3.3.1 DC Offset

Notice that when the voltage offset is used, the signal cannot exceed a peak value of 10 V in open circuit (± 5 V, 50 Ω) so that clipping does not occur.

3.3.2 Use of the pulse output

When this output is used, it is recommended that the connection lead is charged at the other end because of its characteristic impedance, in order to avoid ringing due to reflections in the lead.

The pulse of this output is found around the positive peak of the triangular signal, or on the rise edge of the square signal. Notice that the symmetry control of the main output will act on the TTL pulse output, lowering the repetition frequency of those pulses.

4 OPERATION PRINCIPLE

4.1 Description of the circuit

The general structure of the instrument can be seen in the block diagram (Figure 4.).

The basic signal generated in the GF-232 is the triangular. This is what appears in capacitance C terminals when charged by a constant current (rising ramp) and discharged in the same way (falling ramp).

When undertaking this process, the frequency can vary in two different ways; either varying the magnitude of the charge and discharge currents or varying the capacity to charge and discharge.

Frequency variations in the GF-232 are effected as follows:

- Through continuous control (one decade); the [17] control on the front panel, by varying the charge and discharge currents governing 1C1B with one voltage. It is possible to add to this voltage another external voltage (VCO), through the [18] VCO input.

- By decade jump, which may be done in two ways: by changing the charge and discharge constant currents, or by changing the capacitance from C2 to C6.

- The variation of symmetry of the main signal is provided through the reduction of charge/discharge current of C, as the case may be.

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Generation of the square signal

With the triangular signal amplified previously, a trigger circuit is activated when the voltage in the terminals of the C capacitance reach determined values.

The square signal generated this way also controls the two constant current generators, either the charge or the discharge.

The inhibition of one or the other generator is done with a gate circuit. The previous amplifier of the triangular signal of the generators is IC3, so as not to affect the charge and discharge currents of C.

A circuit at the output of the square convertor allows the user to obtain either the signal with only positive excursion or both, thereby obtaining the two functions: the positive or negative pulse.

Generation of the sinusoidal signal

The method used is that of shapping the triangular signal by segments, using the bend of the V/I characteristic of the diodes D26 to D41.

The output amplifier

Once the three functions are generated, proceed to the selector and later the output amplifier, which includes controls for the amplitude, the addition of offset voltage and the output attenuator.

Frequency counter

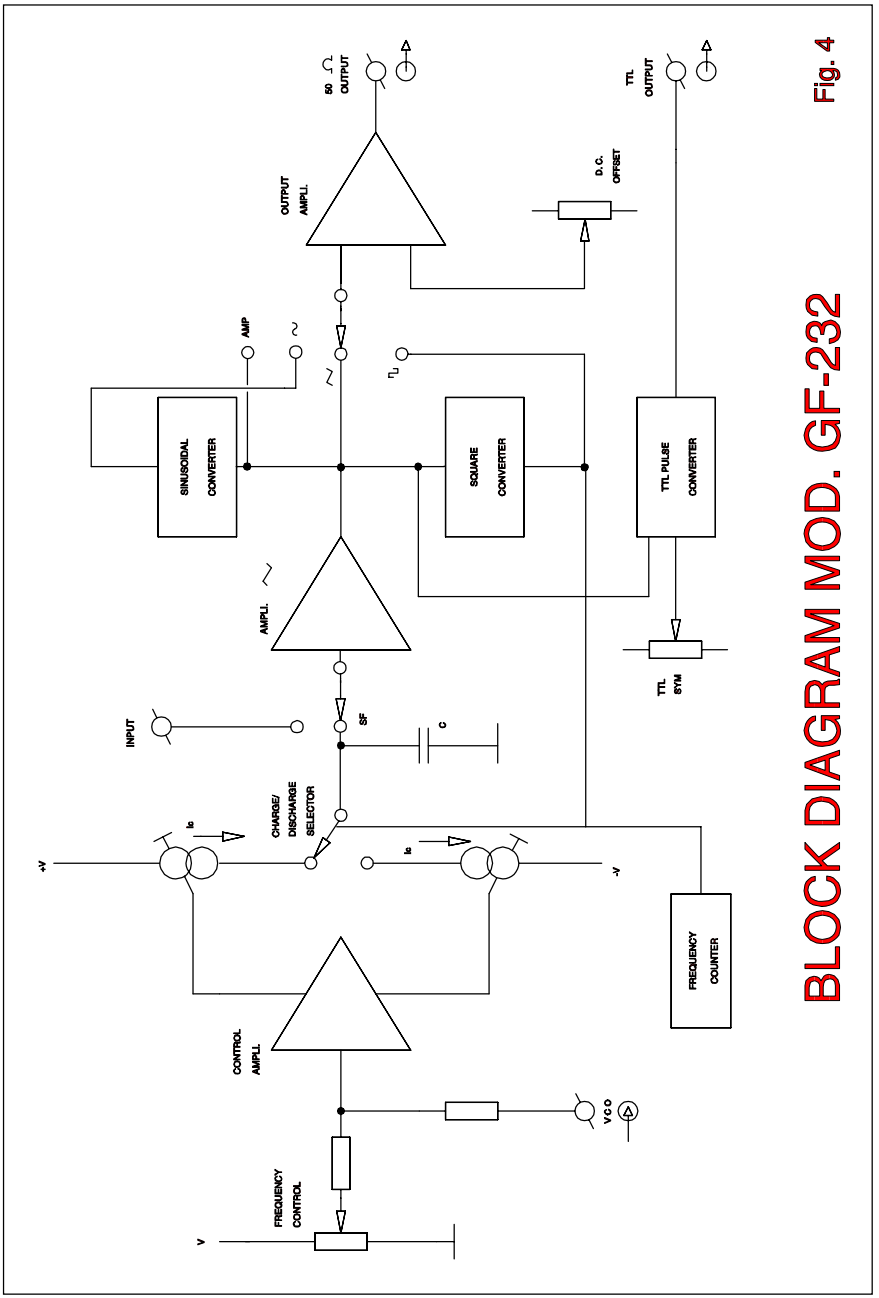
An ASIC circuit forms the complete frequency counter, which includes the time base, the control circuits, the counters and drivers of the LCD display. At the input, the signal passes through the frequency multiplier and division circuitry, which enables each band to rise to the appropriate resolution.

External amplifier

In the frequency counter, amplifier and comparator functions, the SF selector connects the high impedance amplifier to the external input, so it can be utilized as an input pre-amplifier in these functions. The TTL converter acts as the output of the comparator function.

The TTL pulse generator

The positive pulses are obtained by passing the triangular signal through the trigger circuit formed by IC7 in Schmitt trigger circuitry. The asymmetry of the output signal is achieved through the appropriate level of comparison in the input.


BLOCK DIAGRAM MOD. GF-232
Fig. 4
50 Ω OUTPUT
TTL OUTPUT
OUTPUT AMPL.
D.C. OFFSET
AMP
SINUSOIDAL CONVERTER
SQUARE CONVERTER
TTL PULSE CONVERTER
AMPL.
TTL SYM
INPUT
SF
C
CHARGE/ DISCHARGE SELECTOR
Io
+V
-V
FREQUENCY COUNTER
CONTROL AMPL.
VCO
FREQUENCY CONTROL
V

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