Westinghouse

TYPE S
TRANSISTOR RAMP FUNCTION GENERATOR

The transistor ramp function generator is a static replacement for a motor operated rheostat which acts to accelerate or decelerate a motor to a preset speed. It supplies an output which changes linearly with respect to time when the reference voltage is abruptly changed.

The speed of a d-c motor will follow the output of the ramp function generator. It will accelerate or decelerate at a constant rate by time limit control regardless of the magnitude of the preset motor speed called for. As a result, the motor is protected during rapid changes of the reference voltage or speed setting rheostat.

In those cases where stopping of a drive includes dynamic braking or current limit, a normal or emergency stop could conceivably decelerate the d-c motor more rapidly than the rate determined by the ramp function generator. To cover this situation, a resistor and contact can be used in parallel with the capacitor combination in the ramp function generator package. This arrangement discharges the capacitors to make certain that the drive is ready to accelerate again as soon as the anti-plugging protection will so permit.

The ramp function generator can best be described by dividing it into two basic parts. One includes two constant current generators operating alternately for acceleration and deceleration; the other, a power amplifier.

OPERATION

The purpose of this ramp function generator is to convert a step or abrupt input voltage change into a linear and gradual output change. This is accomplished by charging or discharging a capacitor combination with a constant flow of current to or from it. Refer to Figure 1.

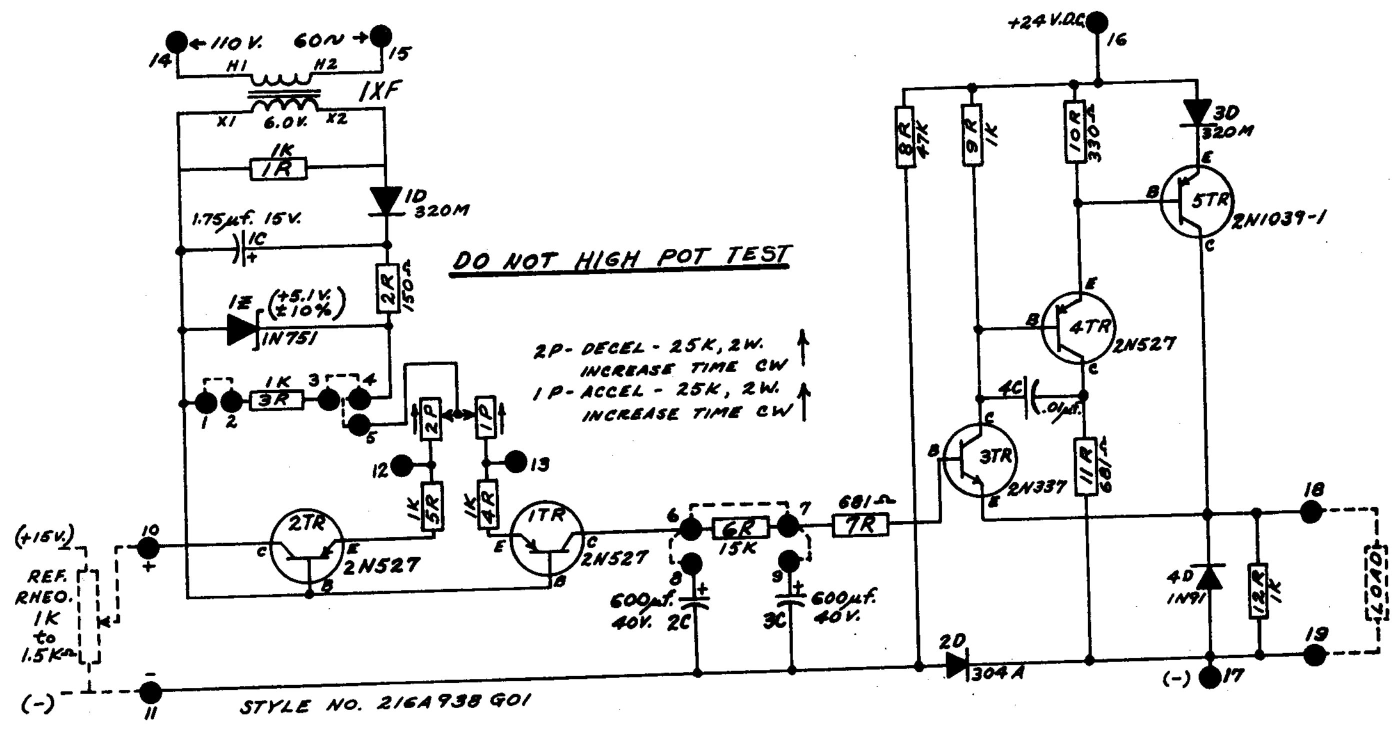

Figure 1 - Type S Ramp Function Generator Schematic Diagram

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NEW INFORMATION

Acceleration-Deceleration Function

Operation of the timing circuit begins when a change in reference voltage is made. Assume that the slider on the reference potentiometer is moved towards the positive end. This will create a potential difference between the reference voltage and the voltage across the capacitor combination (2C and 3C). As a result of this difference, current will flow from the collector of transistor 2TR to its base. (The collector to the base function may be considered at this point as a diode allowing current to flow.) The current flow continues from the base through the bias circuit, Zener diode 1Z, or resistor 3R, through potentiometer 1P, and resistor, 4R, to the emitter of transistor 1TR. Transistor 1TR, is permanently biased so that its emitter is positive with respect to its base. The flow of current through the resistor and potentiometer, 4R and 1P, will increase this bias to regulate current flow at a constant rate from the emitter, through the collector, to the capacitor combination.

The amount of current which is permitted to flow is controlled by potentiometer 1P. As the resistance of 1P is increased, less current flows and the capacitor charging time increases. Conversely, a reduction in the resistance 1P allows the capacitors to charge at a faster rate. While this current is flowing, the emitter of transistor 1TR is made less positive with respect to the base. The decrease is proportional to the amount of current flow and results in a self biasing circuit. This tends to regulate the flow of current and maintain a nearly constant value regardless of the magnitude of the existing potential difference between the reference and capacitor voltages.

The current flow continues until the capacitors are fully charged and the voltage across them is equal to the applied reference voltage.

Deceleration operation is similar to acceleration except the capacitor combination voltage is higher than the reference voltage. The capacitors discharge causing current to flow back to the reference. The functions of 1TR, 2TR, 1P, 4R, 2P and 5R are reversed. The use of resistor 6R is optional. Its function is to make the ramp function output rounded on the start and finish of the charge or discharge of the capacitors, 2C and 3C.

Power Amplifier Function

Transistors, 3TR, 4TR and 5TR form a three (3) stage power amplifier which follows the charging and discharging of the capacitors. The voltage change across the load is proportional to the changes in voltage across the capacitor. The load may be a control winding of a magnetic amplifier, trinistor gating amplifier, or a resistor across the input of an amplifier.

During steady state conditions, the base of transistor 3TR is at the same potential as the capacitors at terminal 7. As the capacitors are charged, the base of 3TR is biased positive with respect to the emitter. The positive collector of the transistor 3TR will therefore draw its current through the resistor 9R and through the emitter - base junction of transistor 4TR. This small current produces a junction voltage drop between the emitter and base of 4TR permitting a heavier current to flow through transistor 4TR, from emitter to collector. The heavier current through transistor 4TR, is supplied through resistor, 10R, and through the emitter - base junction of transistor 5TR. This current produces a junction voltage drop between the emitter and base of 5TR permitting the load current to flow through transistor 5TR from emitter to collector, and then through the load. The voltage appearing across the load will very nearly equal the voltage across the capacitor combination.

In order for transistor 3TR to conduct, a small voltage drop, in the order of 0.4 volts, must exist across its emitter (−) to base (+) junction. This voltage drop is balanced out by the drop across the diode 2D which is forward biased by resistor 8R. Hence the capacitor combination is returned to the negative load terminal, through diode 2D. The base of transistor 3TR is effectively forward biased by the voltage drop across the diode 2D, which is also in the order of 0.4 volts. The total offset between the load voltage and the capacitor combination voltage will then be less than 0.1 volt.

This three stage amplifier permits the capacitor combination to act as an input signal without losing its charge because transistor 3TR represents a very high impedance and blocks any appreciable current flow from the capacitors.

When the capacitor combination has been fully discharged due to deceleration requirements, the base of transistor, 3TR, will be nearly zero and the voltage measured across the load will be nearly zero; hence there will be no self biasing effect obtained from the load. The small current which had been flowing through resistor 9R, transistor 3TR, and then through the load is stopped because 3TR is no longer conducting as its base to emitter voltage is nearly zero. When 3TR is no longer conducting this in turn cuts off transistor 4TR and 5TR. To insure that the voltage is nearly zero across the load, diode 4D is in parallel with the load and in series with 5TR. This diode has a low impedance to the leakage current through 5TR and thus the load is kept at nearly zero volts. Diode 3D is a self biasing diode for 5TR. Also, it tends to reduce leakage along with 4D.

When the 24 V D.C. power is removed, if the capacitor combination is at full charge, resistor, 7R, and transistor 3TR become the discharge path for the current. Resistor 7R is of high enough impedance that no damage to 3TR will result. This is a safety feature to prevent damage to 3TR. If either or both the 15 V D.C. reference or 110 V A.C. bias supply are removed the capacitor combination will slowly discharge through 7R, 3TR and the internal leakage of the capacitors. No damage will result from this, even if the reference input is removed completely. The function of capacitor 4C is for amplifier stability.

TROUBLE SHOOTING

For best results in trouble shooting, it is recommended that the package be removed from the drive and tested separately. The equipment required for test is as follows:

1. A 110 volt A.C. 60 cycle power supply. Minimum rating 5VA.

2. (a) A 24 volt D.C. isolated variable power supply (variable from 21 to 28 volts D.C. - Minimum Rating 300 MA.

   (b) A 15 volt D.C. isolated power supply connected through a 1000 to 1500 ohm rheostat per Figure One. Minimum rating 20 MA.

3. Vacuum tube voltmeter with suitable scales for reading the following:

   0 - 110 volts A.C.
   0 - 50 volts D.C.

4. Multiple scale milliammeter or separate milliammeters with suitable scales for reading the following:

   0 - 500 Milliamperes D.C.
   10 - 0 - 10 Milliamperes D.C.
   1 - 0 - 1 Milliamperes D.C.

WARNING

Do not attempt to repair this unit unless you are familiar with transistors and unless you are properly equipped to test the units after the repair work is completed. If in doubt, substitute a spare unit and have the malfunctioning unit returned, through the nearest Westinghouse Office, to Westinghouse Control Division, Buffalo, New York.

DO NOT HIGH POT (VOLTAGE) TEST THESE UNITS. IN TESTING THE REST OF THE CONTROL, FIRST DISCONNECT ALL LEADS FROM THE RAMP FUNCTION GENERATOR.

Test Procedure

1. Check the wiring carefully before testing.

2. Connect terminal 6 to 7. Connecter terminal 8 to 9. Then connect the milliammeter in series between terminals 6 and 8.

3. Connect terminals 1 to 2. Connect 3 to 4 and 4 to 5.

4. Apply 15 V D.C. isolated source to terminals 10 and 11 through a 1000 to 1500 ohm rheostat as shown in Figure 1. Apply 24 V D.C. isolated source to terminals 16 (+) to 17 (–). Apply 110 V, 60 cycle source to terminals 14 and 15.

5. Move the reference rheostat towards zero volts, terminal 11. Set 1P and 2P at minimum time. Energize all power supplies.

6. Check voltage on terminal 4 (+) to 1 (–) for 5.1 volts D.C. ± 10%.

7. Check voltage on terminal 18 (+) to 19 (–) 0 to 50 millivolts maximum.

8. Move reference rheostat rapidly to maximum reference and check and record the following:

   (a) Charging Current *
       During Build-up 3 to 5 milliamperes
   (b) Delay time (0 to 15 V) T = .005 x C (MFD) ± 10%

9. Move reference rheostat rapidly to minimum reference and check and record the following:

   (a) Charging Current *
       During Discharge 3 to 5 milliamperes
   (b) Delay time (15 to 0 V) T = .005 x C (MFD) ± 10%

10. Set 1P and 2P at maximum and repeat test of step 8 and 9 and check and record.

   (a) Charge and Discharge Current * 0.1 to 0.2 milliamperes.
   (b) Build up and Delay Time T = 0.1 C (MFD) ± 1%

11. Connect 50 ohm load to terminals 18 and 19, and repeat steps 8, 9 and 10.

12. Disconnect terminal 9. This puts only one (1) capacitor into circuit. Repeat steps 8, 9, 10 and 11.

13. Remove milliammeter from step 2. Remove Jumper on terminal 6 and 7. Connect terminal 6 to 8 and 7 to 9.

14. Set 1P and 2P to minimum time and move reference rheostat rapidly to maximum. Record time. It should be between 30 to 40 seconds (0 to 15 V). Set reference rheostat to minimum (15 to 0 V). Time should be the same.

15. Set 1P and 2P to maximum time, and repeat step 14. Times should be 120 seconds ± 10%.

16. With the output voltage at 15 volts, vary the 24 volt D.C. supply from 21 to 28 volts. Output voltage should change ± 1% maximum.

17. Return all jumpers and external connections to original per controller wiring diagram, before installing.

*Note: Current to be constant ± 1.5% during Build-up or Decay