MODEL 436.11
CONTROL UNIT

002-662M

MTS

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INTRODUCTION

The MTS Model 436.11 Control Unit (see figure 1-1) provides manual or automatic control of system electrical power, hydraulic pressure, program run/stop and program event counting. Options are available for Soft Run/Stop and for X100 Counter Capacity. A Function Generator or Ramp Generator may be added as optional modules.

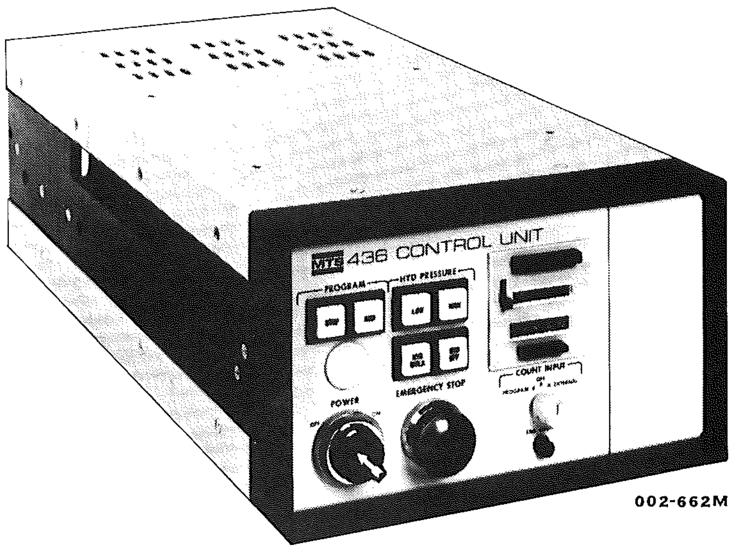

Figure 1-1. Model 436.11 Control Unit

1.1 <u>FUNCTIONAL DESCRIPTION</u>

1.1.1 CONTROL UNIT

The 436.11 Control Unit provides on-off control of an electrohydraulic system. The hydraulic power supply as well as the hydraulic manifold may be turned on or off and switched between high and low pressure from the control unit. An external function generator may be turned on or off using the program RUN/STOP controls.

The control unit contains two interlocks that automatically stop the system if an abnormal condition occurs. One interlock stops the programmer and removes hydraulic pressure, causing removal of the applied load. The other interlock stops the programmer, allowing any static (SET POINT) load to remain.

The electromechanical cycle counter comes equipped and wired to count program events (usually cycles) up to 999,990 at frequencies to 200 Hz. Jumpers inside the unit can be changed to provide a capacity of 99,999 (20 Hz maximum).

1.1.2 SOFT RUN/STOP (OPTION A)

This circuit provides a gradual turn-on and turn-off of the dynamic program signal from one or more external programmers and from the internal function generator (option B) or ramp generator (option C). Soft run/stop ensures a gradual build-up and decay of the dynamic command. Without it, full scale command is typically applied abruptly upon initiation of the RUN command, and withdrawn on initiation of the STOP command. If option B or C is supplied, up to four soft run/stop channels are available. Without option B or C, up to eight channels are available. Turn on time is adjustable from approximately 0.7 to 7 seconds. Corresponding turn off times are approximately .17 to 1.7 seconds. Inputs are available for a remote separately ordered Master Span control that determines the amplitude of the dynamic command to all eight (or four) channels simultaneously.

1.1.3 FUNCTION GENERATOR (OPTION B)

The plug-in function generator provides a positive or negative-starting triangular, square or sine program waveform, continuously adjustable within a frequency range of 0.01 to 1110 Hz. All waveforms start and stop at zero volts. The function generator is controlled by the STOP/RUN switch/indicators and its output may be connected through one of the option A circuits. The output is automatically connected to the PROGRAM counter input.

The output signal amplitude (±10 volt full-scale) may usually be attenuated by the SPAN control on the controller. Option B cannot be used if option C is used.

1.1.4 RAMP GENERATOR (OPTION C)

The plug-in ramp generator provides a positive or negative-starting single ramp or cyclic ramp program waveform, continuously adjustable within six decade rate ranges from 0.0001% to 1000% of system operating range per second. The ramps start and stop at zero volts. The unit is controlled by UP, DOWN, HOLD, RETURN, and CYCLE switch/indicators on a remote, hand-held control unit. The ramp generator may be controlled by external sequence logic for automatic operation instead of by the remote control unit.

The ramp output may be connected through one of the option A circuits and is automatically connected to the program counter output. The output signal amplitude (±10 volt full-scale) may usually be attenuated by the SPAN control on the controller. Option C cannot be used if option B is used.

1.1.5 X100 COUNTER CAPACITY (OPTION D)

A second count divider circuit may be added to extend the counter capacity to 9,999,900 (1kHz maximum). This X100 condition is selected by jumper placement inside the unit. The counter can be preset to open either of the interlocks to stop the system at the end of a desired number of events.

1.2 SPECIFICATIONS

1.2.1 CONTROL UNIT

1.2.1.1 General

Operating temperature range	10° to 40° C (ambient)
Power requirements	105/125 Vac or 210/250 Vac, 50 or 60 Hz, 15 W max. (without options)
Shipping weight	20 lbs (9 kg)
Length	18.5 in. (47 cm)
Width	8.85 in. (22.5 cm)
Height	5.25 in. (13.3 cm)

1.2.1.2 Control Circuitry

K1, K2, K4 contacts	0.1 W, 10 V min. 100 W, 115 Vac inductive max.
K3 contacts	30 W, 115 Vac inductive max.
Counter end-of-count contacts	100 mA max.
Interlock response	20 msec (typical)
Counting rate (X1)	20 Hz max.
Counter input filter/buffer:	
Bandwidth (without filter)	1 kHz (with 20 Vpp input)
Bandwidth (with filter)	2 Hz min.
Must count input signal	+ 3 Vdc at 30 µA
Input Impedance	500 kΩ minimum to -15 V

1.2.2 SOFT RUN/STOP (OPTION A)

Operating temperature range	10° to 40° C
Power requirements	+15 Vdc ±2%, 12 mA (plus 14 mA per channel) max. -15 Vdc ±2%, 12 mA (plus 14 mA per channel) max -26 Vdc ±20%, 0.02 mA max. Total; 625 mW (plus 730 mW per channel) max.
Input voltage (pin 18)	±15 volts - no damage ±10 volts - full scale
Input impedance (pin 18)	1 MΩ min.
Output voltage (pin 9)	±10 volts - full scale
Output current (pin 9)	±5 mA max. operating
Output impedance (pin 9)	.2Ω max.
Frequency response of output voltage (pin 9)	down ±3 db at 2 kHz
Gain drift with temperature (pin 9)	0.03%/°C max.
Zero drift with temperature (pin 9)	0.1 mV/°C max.
Linearity of PROGRAM turn on or turn off	±2% deviation max.
Turn on time (RATE)	0.7 to 7 sec. (adjustable)
Turn off time (RATE)	0.17 to 1.7 sec (turn on time/4)
MASTER SPAN input impedance (pin 4)	90 kΩ min.

1.2.3 FUNCTION GENERATOR (OPTION B)

Power requirements	±15 Vdc, 100 mA max. Supplied by 436 Control Panel
Waveforms available	Sine, square, triangle
Output amplitude	
Sine[1]	±10 volts (adjustable)
Square	±10 volts ±100 mV
Triangle[2]	±10 volts ±25 mV
Output resistance	0.5 Ω min.
Output load	R = 1.0 kΩ min. C = 0.01 °F max.
Output amplitude drift	
Sine	±0.02%/°C max.
Square	±0.005%/°C max.
Triangle	±0.005%/°C max.
Sine wave distortion	Less than 1.0%
Frequency	0.01 to 1.1 kHz (in 5 ranges) within ±2% of the dial setting
Frequency drift	±0.01%/°C max.
Symmetry	±1.0% max.
Nonrun dc level	-10 mV max.
Nonrun dc level drift	±0.1 mV/°C max.

1.2.4 RAMP GENERATOR (OPTION C)

Operating temperature range	10 to 50°C (ambient)
Operating relative humidity range	0 to 85%
Power requirements	+15 Vdc ±0.75 Vdc, 65 mA max. -15 Vdc ±0.75 Vdc, 65 mA max. +28 Vdc +1, -2 Vdc, 230 mA max.
Output range	±10 volts
Output resolution:	
0.01% to 10%/sec. ranges	0.3 mV
100 and 1000%/sec ranges	5 mV
Output accuracy (at ± full-scale)	10 mV
Output stability (at hold)	±0.002%/°C, ±0.002%/24 Hours
Output linearity (monotonicity)	±0.012% (10 to 40°C)
Output offset (at zero)	±2 mV
Output current	4 mA max. (2.5 kΩ min. load impedance)
Output impedance	0.1 Ω
Rate accuracy	1%
Rate stability	0.015%/°C
Rate linearity	0.1%
Rate[3] range	1×10^{-4}%/sec to 1000%/sec (in 6 ranges selectable from 0.0001 to 1000)

[1] Output can overshoot by 4 mV for each 100 Hz greater than 100 Hz. For example 36 mV overshoot can be expected for a frequency of 1 kHz.

[2] Output can overshoot by 20 mV for each 100 Hz greater than 100 Hz. For example 180 mV overshoot can be expected for a frequency of 1 kHz.

[3] RATE can be adjusted to 0%/second; 1×10^{-4}/second is 1/100 of the 0.01%/second range, and is used as a reasonable lower operating limit.

SECTION II
OPERATION

2.1 CONTROLS AND INDICATORS

The following paragraphs describe the controls and indicators, and their functions.

2.1.1 CONTROL UNIT

See figure 2-1 for the location of the following controls and indicators.

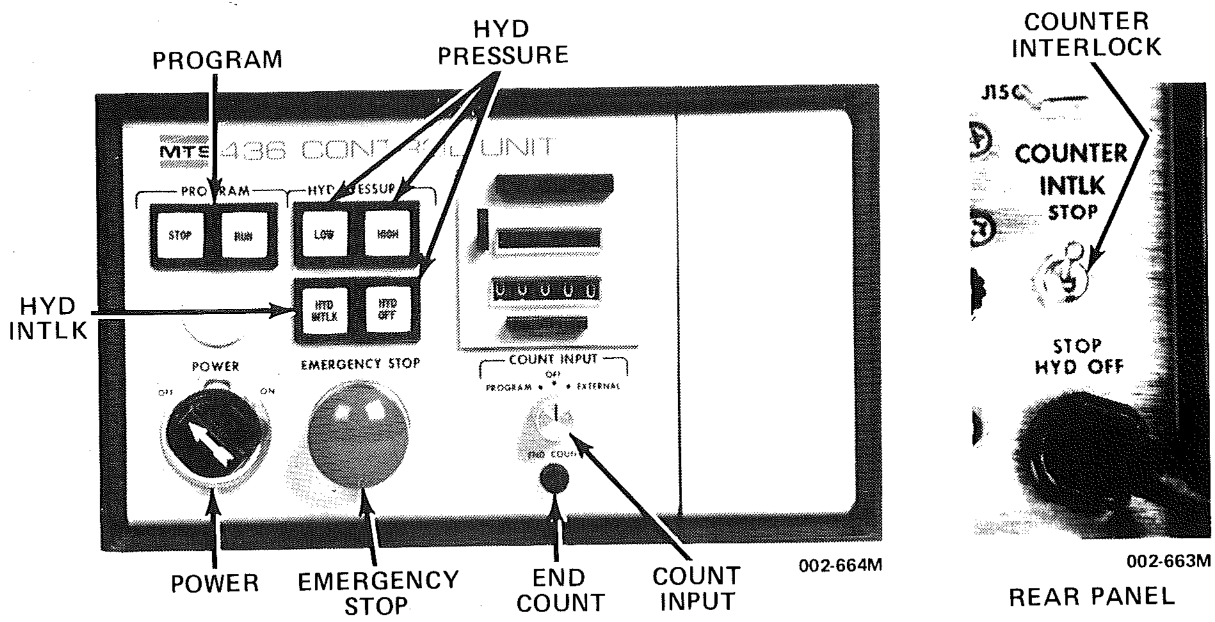

Figure 2-1. Control Unit-Controls and Indicators

The POWER switch applies ac operating power to the control unit and to any other unit(s) plugged into the ac receptacle on the rear panel.

The HYD PRESSURE switch-indicators control hydraulic pressure to the servovalve(s) provided no abnormal condition exists and PROGRAM STOP is lit.

Several configurations for obtaining the LOW, HIGH, and OFF pressure conditions are possible. In single channel systems, these buttons usually control the hydraulic power supply. In some multi-channel systems, they control valves in a hydraulic manifold between the supply and the servovalve. See paragraph 2.3.1.

CAUTION

> Before applying hydraulic pressure to the servovalve(s), adjust SET POINT on the controller to move the panel meter (ERROR position) as close to null as possible. This will help prevent actuator "jump" when pressure is applied.

The PROGRAM switch-indicators control the RUN/STOP functions of programmers and readout equipment. The switches are active even if hydraulic pressure is not applied. STOP must be lit in order to apply pressure. Some systems make use of a SOFT RUN/STOP OPTION that brings programmer signals up gradually when RUN is depressed. A stop interlock circuit can be used to prevent or drop out the RUN condition.

The HYD INTLK (hydraulic interlock) switch-indicator is associated with abnormal condition sensors in the controller and the overtemperature and low fluid level conditions of the hydraulic power supply. The indicator will light when any such condition occurs. At the same time, hydraulic pressure is automatically removed from the servovalve(s) and the programmer(s) stop. When the abnormal condition has been removed, HYD INTLK extinguishes. Pushing and holding HYD INTLK allows the system to be restarted without removing the abnormal condition, unless that condition is hydraulic fluid overtemperature or low level.

Pushing the EMERGENCY STOP button while the system is operating causes the hydraulic power supply to turn off and the program to stop. In single channel systems, EMERGENCY STOP and HYD OFF have the same effect.

COUNT INPUT selects the source of the events to be counted by the electromechanical counter and allows the counter to be turned off. The PROGRAM position selects the programmer, option B or C (if supplied), connected to J21 on the rear panel; EXTERNAL selects an external source connected to J22.

NOTE

> Option C must be operated in the bipolar mode to trigger the electromechanical event counter.

The electromechanical event counter may be used to indicate program events or to predetermine the number of events to be applied. To preset the counter, stop the counting, depress and hold the red button on the upper register, push down on the lower register tab, and preset the desired count in the lower register by pushing individual black buttons. To count events without stopping the test, the number in the lower register must be higher than the number of events to be applied. Standard counter capacity is either 99,999 (X1) or 999,990 (X10). Some systems are supplied with a X100 option that expands the counter to 9,999,900. The multiplier in use is determined by the connection of jumpers inside the unit. Unless otherwise specified, the control unit is supplied with the jumpers in the X10 position.

The END COUNT indicator lights when the upper counter register reaches the pre-set count. At the same time, an action determined by the COUNTER INTLK switch occurs.

The COUNTER INTLK switch determines whether an END COUNT causes complete system shutdown including removal of hydraulic pressure (STOP-HYD OFF position) or only program stop (STOP position).

2.1.2 SOFT RUN/STOP (OPTION A)

The soft run/stop feature (option A) does not include any panel mounted controls or indicators.

2.1.3 FUNCTION GENERATOR (OPTION B)

See figure 2-2 for the location of the following controls and indicators.

The waveform selector on the optional function generator allows the operator to select positive (+) or negative (-) starting square, triangle, and sine program waveforms.

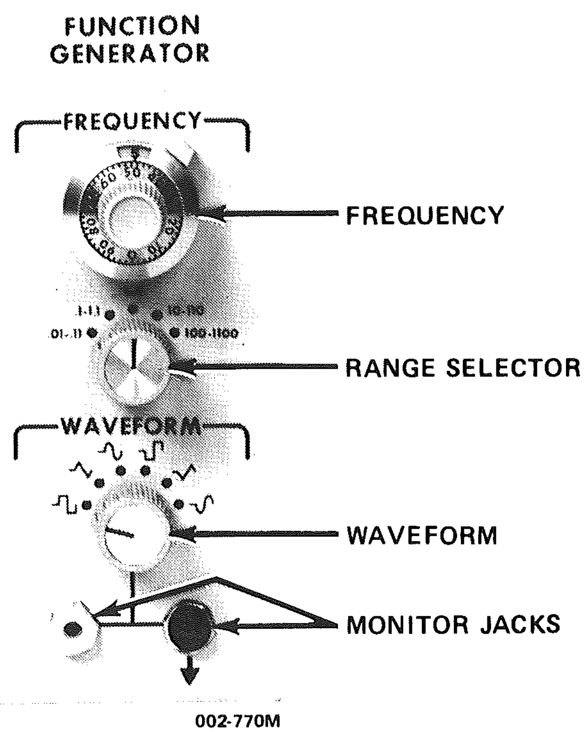

Figure 2-2. Function Generator (Option B) - Controls and Indicators

The FREQUENCY vernier and its associated range selector determine program frequency.

2.1.4 RAMP GENERATOR (OPTION C)

2.1.4.1 Internal Controls

The following switches which are mounted on the printed circuit boards are not shown in figure 2–3. The locations are described when looking at the component side with the front panel to the right.

RT RANGE SEL (return range select) switches - This set of 3 rocker switches is mounted near the bottom of the main printed circuit board and just to the left of the small printed circuit board. These switches permit selection of a return rate range which may be different from a ramp rate range. Table 2-1 shows the relationship between the switch settings and the range selected.

Table 2-1. Return Rate Switch Settings

		Switch Settings (1 = Off, 0 = On)		
		2^2	2^1	2^0
Ranges (%/sec)	0.0001--0.01	0	1	0
	0.01--0.1	0	1	1
	0.1--1	1	0	0
	1--10	1	0	1
	10--100	1	1	0
	100--1000	1	1	1

POL (polarity) switch - This 3 position slide switch is located in the top center of the small printed circuit board. Sliding the switch to the extreme left selects negative operation. Sliding the switch to the extreme right selects positive operation. Placing the switch in the center position selects bipolar operation (both positive and negative).

NOTE

The POL (polarity) Switch must be in the center (bipolar) position if option C is to trigger the electromechanical event counter.

2.1.4.2 Front Panel Controls and Indicators

Refer to figure 2-3 for the locations of the following controls and indicators.

RAMP RATE control - This is a 10-turn vernier dial which determines the rate of change of the ramp output between 0% and 100% of the range selected by the RATE RANGE switch on the remote test control unit.

HOLD - An indicator lights when the HOLD button on the remote test control unit is pressed or when the hold condition has been externally applied.

OUTPUT AT ZERO - Indicates when ramp output is at zero volts.

RAMP - Test jack which permits direct observation of the ramp output.

VCO - Test jack which is used to observe the output of the voltage controlled oscillator and during calibration.

COM - Test jack providing access to a common ground point.

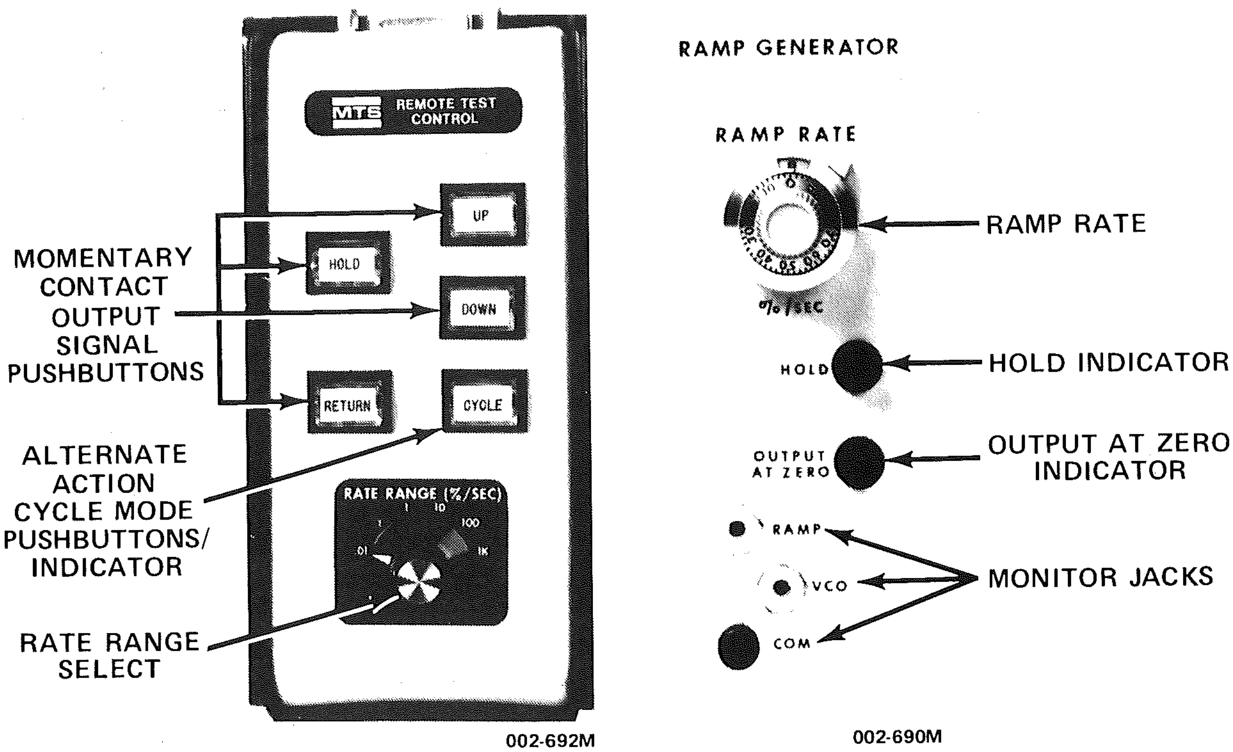

Figure 2-3. Ramp Generator (Option C) and Remote Test Control Unit - Controls and Indicators

2.1.4.3 Remote Test Control Unit Controls and Indicators

See figure 2-3 for location of following controls:

HOLD - A momentary pushbutton which, when pressed, holds the ramp output at its current level.

UP - A momentary pushbutton/indicator which, when pressed, lights and causes the ramp output to go in a positive direction if the ramp is not already at its positive limit.

DOWN - A momentary pushbutton/indicator which, when pressed, lights and causes the ramp output to go in a negative direction if the ramp is not already at its negative limit.

RETURN - A momentary pushbutton/indicator which, when pressed, lights and causes the ramp output to return to zero at a rate determined by the position of the RT. RANGE SEL switches and the RAMP RATE control.

CYCLE - An alternate action pushbutton/indicator which selects the mode of operation. Pressing the button causes the indicator to light and indicates selection of the continuous cycle mode of operation. Pressing the button to cause the indicator to go out indicates selection of the single ramp mode of operation. In the continuous cycle mode, pressing UP or DOWN determines the direction of the initial ramp.

RATE RANGE - A 6-position rotary switch selects the full scale range of the ramp output's rate of change. The ranges for the individual switch positions are shown in table 2-2. The lower limit of each range is determined by assuming that the practical limit of the 10-turn control is 1/100 of full scale.

Table 2-2. Ramp Rate Ranges

		Rate Range (%/sec)
Switch Setting	0.01	0.0001 - 0.01
	0.1	0.001 - 0.1
	1	0.01 - 1
	10	0.1 - 10
	100	1 - 100
	1K	10 - 1000

2.1.5 X100 COUNTER CAPACITY (OPTION D)

The X100 counter capacity feature (option D) does not include any panel mounted controls or indicators other than those used for normal counter operation.

2.2 INTERLOCK CIRCUITS

2.2.1 STOP/HYDRAULIC OFF INTERLOCK (HYD INTLK)

The interlock associated with the HYD INTLK switch/indicator on the 436.11 Control Unit stops the programmer(s) and removes hydraulic pressure if any one of a number of conditions occur while the system is operating. If the system is not operating, these conditions will prevent system start up until the condition is corrected or unless the HYD INTLK button is depressed and held in temporarily to override the interlock. The interlock will not reset (HYD INTLK will not extinguish) until the condition that caused the interlock to open is remedied.

NOTE

> The stop/hydraulic off interlock operates from a 26 Vdc source which is protected by fuse F3 (0.25A) on the main printed circuit board inside the unit. If F3 opens, the interlock opens and the HYD INTLK button will not override the interlock. To check for an open F3 without removing the unit's cover, check for +26 Vdc on pin B of J13A. If the voltage is not present, F3 is open.

Conditions which will open the stop/hydraulic off interlock are given below.

Condition	Indication	Remedy
End of Count (only if COUNTER INTLK is set to STOP/HYD OFF).	END COUNT lit. HYD INTLK lit.	Reset counter.
Servo Controller Error detected.	Error lit on controller panel. HYD INTLK lit.	Push RESET on controller. See controller manual.
Upper or Lower Limit detected.	UPPER or LOWER lit on controller Panel. HYD INTLK lit.	Push RESET on controller. See controller manual.
Limit Switch on actuator set.	HYD INTLK lit.	Reset limit switch. If necessary, push and hold HYD INTLK, apply hydraulic pressure, use SET POINT to move actuator away from switch. See hydraulic actuator manual.

Condition	Indication	Remedy
Hydraulic Fluid Over-Temperature (cannot be overridden by holding HYD INTLK).	HYD INTLK lit.	See hydraulic power supply manual.
Low Hydraulic Fluid Level (cannot be overridden by holding HYD INTLK).	HYD INTLK lit.	See hydraulic power supply manual.
Motor Overload (not part of HYD INTLK).	LOW & HIGH not lit. STOP lit. HYD INTLK not lit.	Check for cause of motor overload and for blown fuse(s). Reset motor starter contacts (inside starter box).
Feedback Limit (only if IND/INTLK switch on amplitude controller is set to INTLK).	FDBK LIMIT on amplitude controller lit. HYD INTLK lit.	Push RESET on amplitude controller. See amplitude controller manual.
Dynamic Program Limit (only if IND/INTLK switch on amplitude controller is set to INTLK).	DYN PROGRAM LIMIT on amplitude controller lit. HYD INTLK lit.	Push RESET on amplitude controller. See amplitude controller manual.

2.2.2 STOP INTERLOCK

If cable(s) are connected to J14A and J14B on the rear panel, a second interlock that stops the program is operative. (Jumper plugs on these jacks indicate that the interlock is not in use except for end of count.) Devices connected to this interlock can stop a program in process or prevent the RUN condition from being initiated while some condition (an end of count from an external programmer, an end of program from a computer, or an unlocked crosshead on load frames equipped with hydraulic crosshead locks) is present. There is no indicator or override button for the stop interlock. The condition that opened the interlock must be removed and the run started again.

Conditions which will open the stop interlock are given below.

Condition	Indication	Remedy
End of Count.	END COUNT lit.	Reset counter.
Load Frame Crosshead Unlocked.	X-HEAD UNLOCK lit.	Lock crosshead.

2.3 OPERATING INSTRUCTIONS

2.3.1 CONTROL UNIT

A 436.11 Control Unit can control hydraulic pressure in a single servo control channel in a number of different ways, depending on system design. For this reason, typical configurations are discussed below. Multi-channel systems using more than one 436.11 Control Unit duplicate the configurations described.

2.3.1.1 Type 1 System

This is the simplest configuration (see figure 2-4): a control unit which controls a hydraulic power supply that has no low pressure condition.

For proper operation of this configuration, there must be no jumper between pins E88 and E90 on the main printed circuit board. This jumper is used for another configuration. If the 436.11 was supplied as part of a system, you can assume that the jumper is not connected.

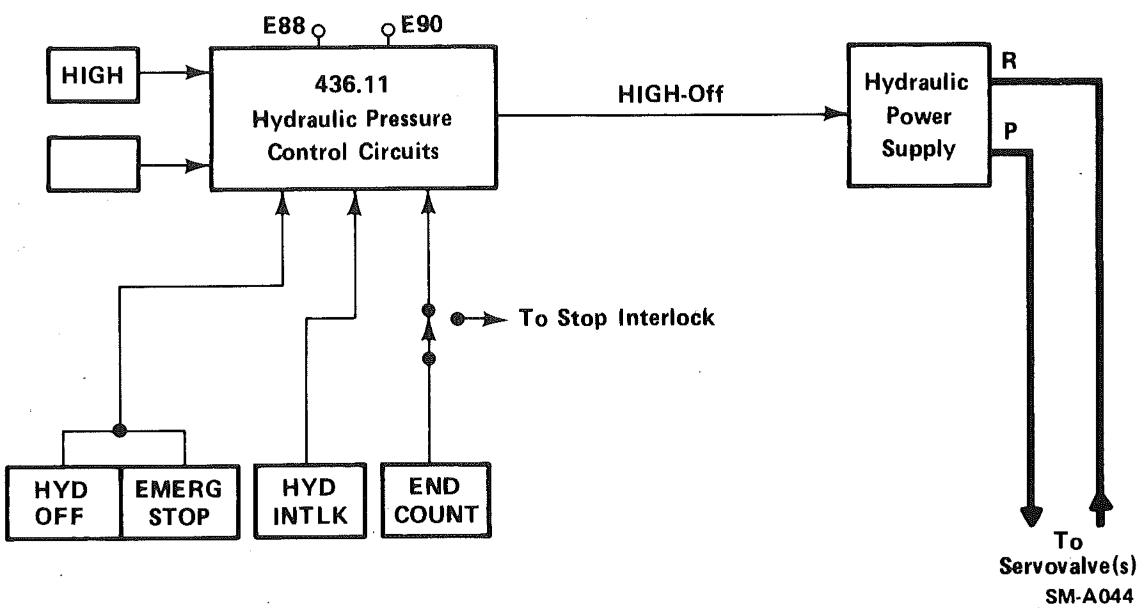

Figure 2-4. Type 1 System

1. With the HYD INTLK button extinguished, STOP lit, and the counter cleared, neither HYD PRESSURE button will be lit. Pressing HIGH will start the hydraulic supply in its high pressure condition and HIGH will light.

2. The hydraulic supply will turn off if HYD OFF or EMERGENCY STOP is depressed, the HYD INTLK opens, or an END COUNT occurs with the COUNTER INTLK switch set to STOP/HYD OFF.

2.3.1.2 Type 2 System

This configuration (see figure 2-5) consists of a control unit which controls low and high pressure from a hydraulic power supply. The hydraulic service manifold is optional.

For proper operation of this configuration, there must be no jumper between pins E88 and E90 on the main printed circuit board. This jumper is used for another configuration. If the 436.11 was supplied as part of a system, you can assume that the jumper is not connected.

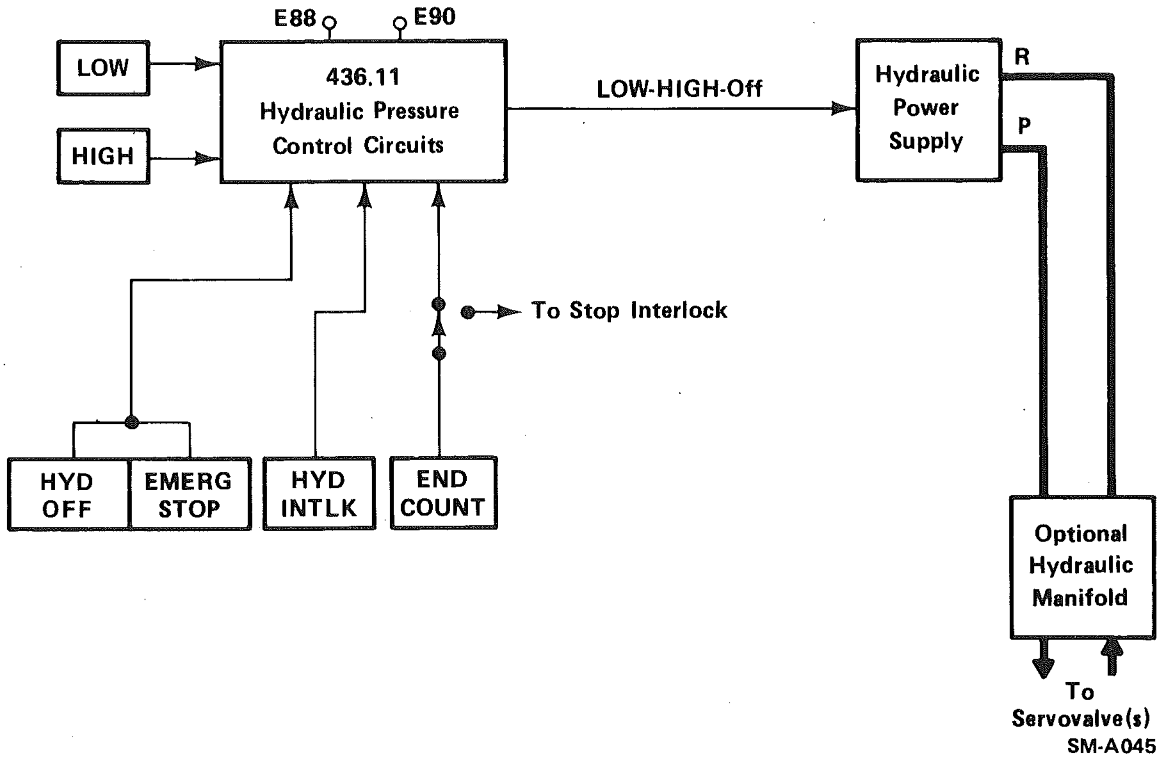

Figure 2-5. Type 2 System

1. With the HYD INTLK button extinguished, STOP lit, and the counter cleared, neither HYD PRESSURE button will be lit. Pressing LOW will start the hydraulic supply in its low pressure condition and LOW will light. Pressure to the servovalve(s) will be 100 psi or less.

2. With LOW indicating, pressing HIGH will cause the hydraulic supply to apply full output pressure (usually 3000 psi) to the servovalve. LOW will extinguish and HIGH will light.

3. Subsequent actuations of the LOW and HIGH buttons will switch the output pressure to the applicable condition.

4. The hydraulic supply will shutdown if HYD OFF or EMERGENCY STOP is depressed, the HYD INTLK opens, or an END COUNT occurs with the COUNTER INTLK switch set to STOP/HYD OFF.

2.3.1.3 Type 3 System

This configuration (see figure 2-6) consists of a control unit which controls both a hydraulic power supply and a solenoid-operated valve in the pressure leg of a hydraulic manifold. The advantage provided by the solenoid valve is quick cut off of pressure to the servovalve at the hydraulic manifold. The load applied by the actuator is relieved faster than would otherwise be the case. The solenoid valve can also be used to isolate individual channels on systems sharing a common hydraulic supply.

For proper operation of this configuration, there must be no jumper between pins E88 and E90 on the main printed circuit board. This jumper is used for another configuration. If the 436.11 was supplied as part of a system, you can assume that the jumper is not connected.

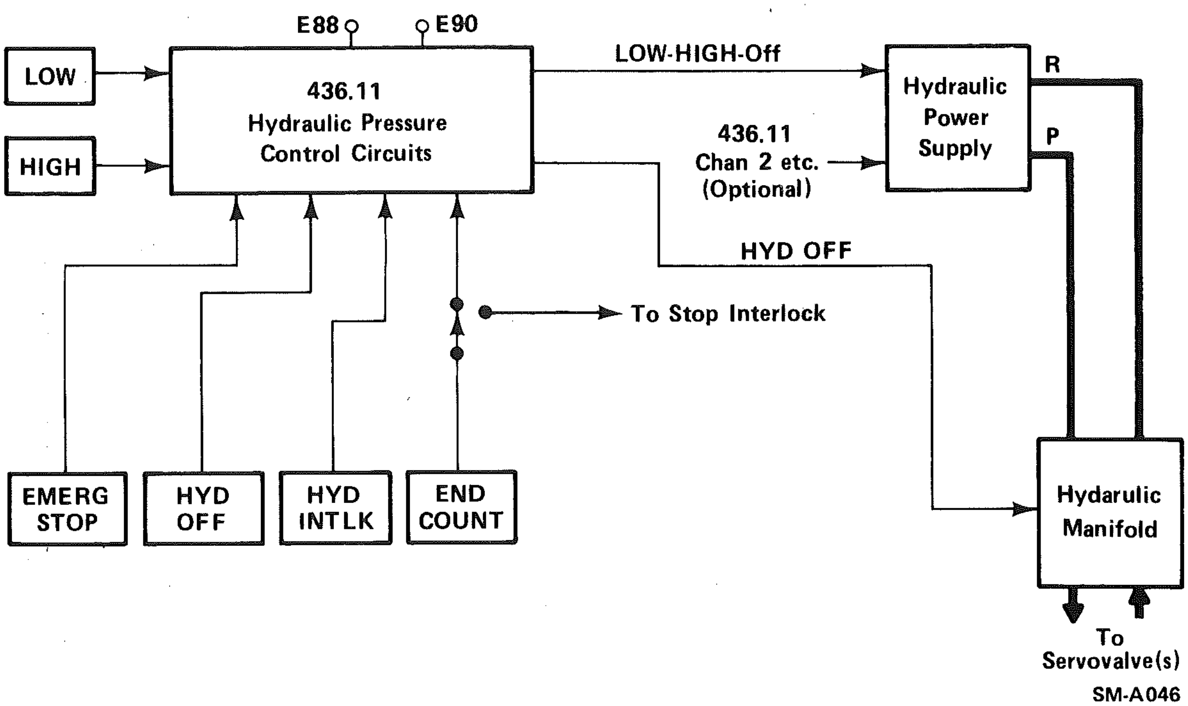

Figure 2-6. Type 3 System

1. With the HYD INTLK button extinguished, STOP lit, and the counter cleared, neither LOW nor HIGH will be lit. Pressing LOW will start the hydraulic supply in its low pressure condition, open the manifold's solenoid valve, and LOW will light. Pressure to the servovalve(s) will be 100 psi or less.

2. With LOW indicating, pressing HIGH will cause the hydraulic supply to apply full output pressure (usually 3000 psi) to the servovalve. LOW will extinguish and HIGH will light.

3. Subsequent actuations of the LOW and HIGH buttons will switch the output pressure to the applicable condition.

4. Pushing HYD OFF will close the manifold solenoid valve but will not turn off the hydraulic supply if another channel or system is also using it.

5. The solenoid valve will close if EMERGENCY STOP is depressed, the HYD INTLK opens, or an END COUNT occurs with the COUNTER INTLK switch set to STOP/HYD OFF. In multi-channel applications, the hydraulic supply will also turn off unless another channel or system sharing the same supply is active (activating EMERGENCY STOP will always turn off the hydraulic supply). In this case, the last 436.11 to shut down its channel or system will also cause the hydraulic supply to turn off.

2.3.1.4 Type 4 System

This configuration (see figure 2-7) consists of a control unit which controls both a hydraulic power supply and two solenoid-operated valves in the pressure leg of a hydraulic manifold. When turned on, the hydraulic power supplies comes up to full pressure (usually 3000 psi) immediately. The two solenoid valves provide LOW, HIGH, and OFF functions at the hydraulic manifold so that a common hydraulic supply may be shared by two or more independently operated channels or systems.

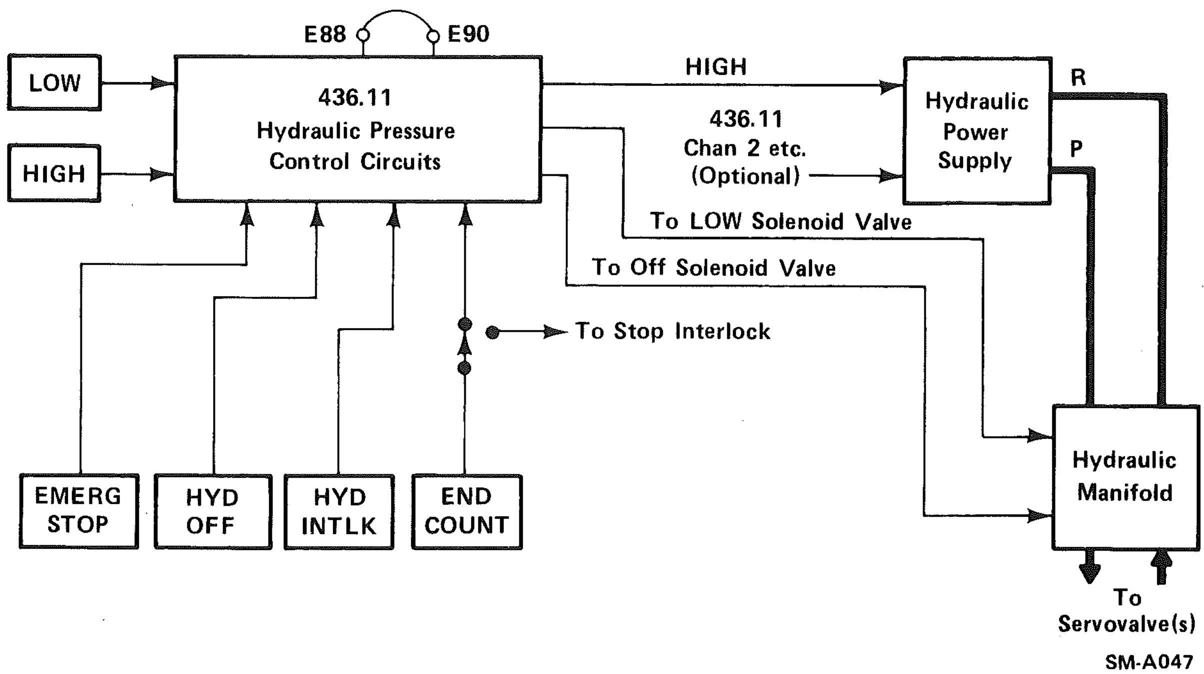

Figure 2-7. Type 4 System

For proper operation of this configuration, there must be a jumper connected between pins E88 and E90 (see figure 2-8) on the main printed circuit board. The jumper causes the hydraulic supply to come up to high pressure immediately upon being turned on. If the 436.11 was supplied as part of a system, you can assume that the jumper has been connected.

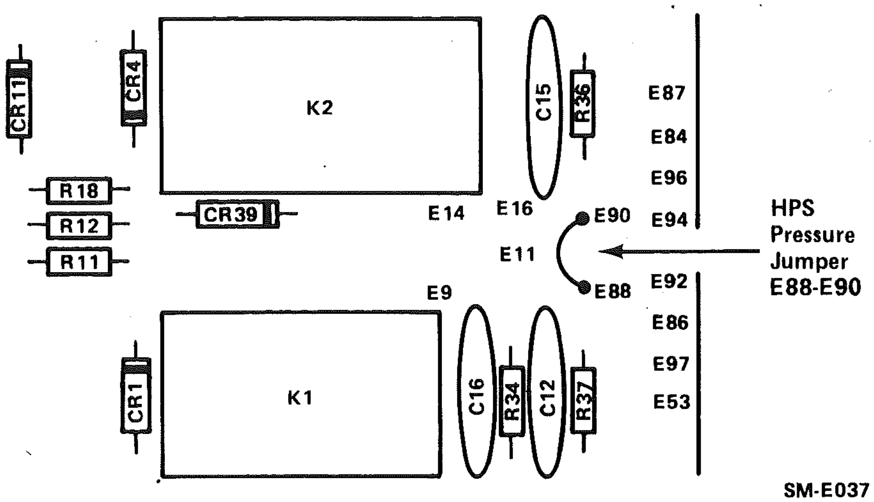

Figure 2-8. Hydraulic Power Supply Pressure Jumper

1. With the HYD INTLK button extinguished, STOP lit, and the counter cleared, neither LOW nor HIGH will be lit. Pressing LOW will start the hydraulic supply in its high pressure condition while activating the LOW solenoid valve. LOW will light. Pressure to the servovalve will be between 75 and 300 psi, depending on adjustment of the pressure reducing valve at the hydraulic manifold.

2. With LOW indicating, pressing HIGH will close the LOW solenoid valve and open the OFF solenoid valve, applying full output pressure (usually 3,000 psi) to the servovalve(s). LOW will extinguish and HIGH will light.

3. Subsequent actuations of the LOW and HIGH buttons will switch the output pressure to the applicable condition at the hydraulic manifold. The hydraulic supply will not be affected.

4. Pushing HYD OFF will close the OFF solenoid valve but will not turn off the hydraulic supply if another channel or system is also using it.

5. The OFF solenoid valve will also close if EMERGENCY STOP is depressed, the HYD INTLK opens, or an END COUNT occurs with the COUNTER INTLK switch set to STOP/HYD OFF. In addition, the hydraulic supply will turn off unless another channel or system sharing the same supply is active (activating EMERGENCY STOP will always turn off the hydraulic supply). In this case, the last 436.11 to shut down its channel or system will also cause the hydraulic supply to turn off.

2.3.2 COUNTER

2.3.2.1 Counter Input Filter

If the input to the counter is from mechanical contacts, connect a jumper between E31 and E32 on the printed circuit board (see figure 2-9). This connects a filter to the input for suppressing "contact bounce" noise. The jumper is not recommended for counting programmer cycles since it limits frequency response.

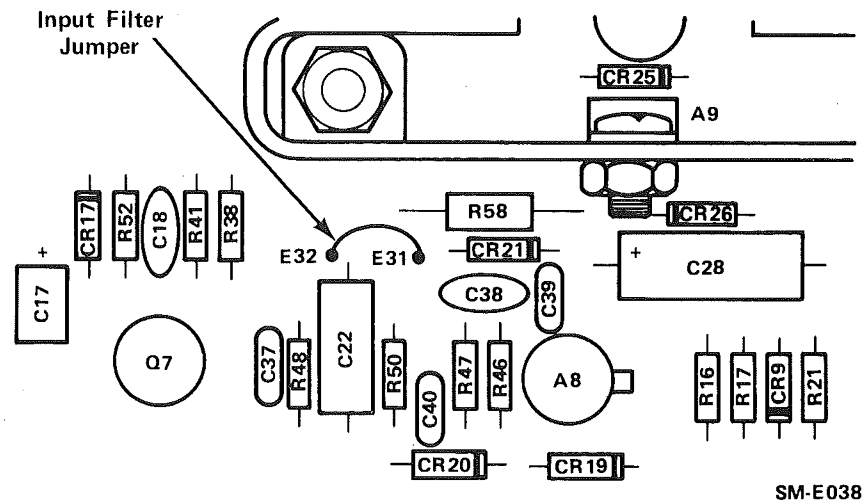

Figure 2-9. Input Filter Jumper

2.3.2.2 Changing the Count Multiplier

The basic capacity of the 5-digit counter is 99,999 counts at frequencies to 20 Hz. This is the X1 capacity. By adding an input divider circuit, every tenth event will be counted, increasing the capacity to 999,990 (X10). Unless otherwise specified the 436.11 comes equipped and wired for the X10 capacity.

Connect the two jumper wires shown in figure 2-11 for the desired count multiplier as follows:

Multiplier	Max. Capacity and Frequency	Jumper Pins
X1	99,999 (20 Hz)	E47 to E49 & E50 to E52
X10 (standard)	999,990 (200 Hz)	E47 to E49 & E51 to E52

Refer to paragraph 2.3.6 for X100 (Option D) operating information.

2.3.3 SOFT RUN/STOP (OPTION A)

One SOFT RUN/STOP circuit card (see figure 2-10) can provide soft run/stop capabilities for up to four channels. A second SOFT RUN/STOP circuit card is required for five to eight channel operation.

To adjust the soft run/stop rate, turn the RATE trimmer(s) counterclockwise to increase the turn on-turn off rate and clockwise to decrease rate. The approximate range of adjustment for turn on is 0.7 to 7 seconds. Corresponding turn off times are approximately 0.17 to 1.7 seconds. The effects of adjustment may be observed by monitoring either the program signal itself or the ramp signal that controls turn-on (jack provided on card). The RUN and STOP buttons will operate the turn-on circuit without hydraulic pressure applied.

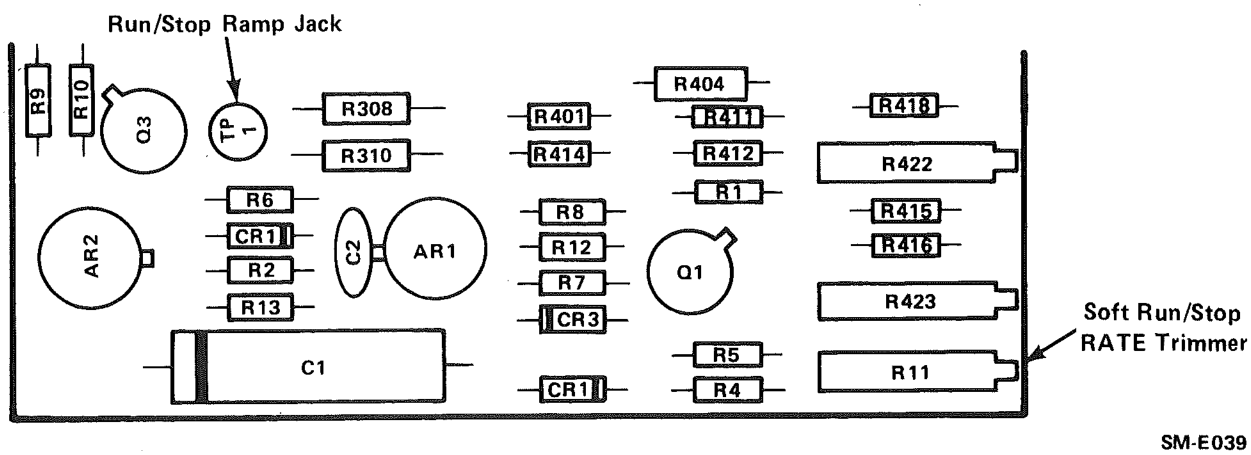

Figure 2-10. Soft Run/Stop (Option A) - Rate Adjustment

2.3.4 FUNCTION GENERATOR (OPTION B)

Operation of the function generator (option B) consists of setting the WAVEFORM selector to the desired waveform and polarity, selecting the desired frequency by setting the FREQUENCY range switch and the FREQUENCY vernier control to the appropriate positions, and depressing PROGRAM RUN on the control unit (to initiate the program).

2.3.5 RAMP GENERATOR (OPTION C)

Operation of the ramp generator consists of setting the internally mounted switches and adjusting the RAMP RATE control on the module itself, and of setting the RATE RANGE switch and selecting the desired function at the remote test control unit, and depressing PROGRAM RUN on the control unit.

2.3.5.1 Ramp Generator Module Adjustment Procedures

1. Slide the 436.11 Control Unit out to the end of its travel.

2. Set the RETURN RATE selection switches for desired ramp return rate. See table 2–1 for the range-to-switch setting relationship.

NOTE

Do not select 000 or 001. The ramp will not return in either of these ranges.

3. Set the polarity (POL) switch for the desired operating mode: +, -, or +/-.

4. Slide the 436.11 Control Unit back into the rack.

5. Adjust RATE control for the desired ramp rate between zero and 100% of the selected full scale range.

2.3.5.2 Remote Test Control Adjustment And Operation

*** WARNING ***

Changing the RATE RANGE switch setting by one increment, causes the rate-of-range-change to increase or decrease by a multiple of 10. If this is done during operation, a hazardous condition can result which could cause injury to personnel and/or damage to the equipment and specimen.

The RATE RANGE switch setting may be changed during operation, provided the new setting does not exceed the safety parameters of the equipment or specimen.

1. Set RATE RANGE switch for desired operating range. See table 2-2. This switch may be changed during operation (see the warning above).

2. Select and initiate desired operating mode with CYCLE switch/indicator

   a. Indicator lit - cyclic mode.

   b. Indicator out - single ramp mode.

3. Select PROGRAM RUN on the controller (STOP automatically engages RETURN to zero).

4. Select and initiate desired ramp direction (which may not correspond to the direction of actuator movement).

   a. UP - ramp positive.

   b. DOWN - ramp negative.

5. To stop the ramp or cycle, press the HOLD button. In ramp mode, pressing UP or DOWN after pressing HOLD causes the ramp to continue from the point of interruption to the limit set for the selected direction, if that limit has not already been reached. In cycle mode, pressing UP or DOWN after pressing HOLD causes the cycle to continue from the point of interruption in the direction selected.

6. To stop a ramp or cycle and return the output to zero, press RETURN. Note that in cycle mode pressing UP or DOWN after having pressed RETURN causes the cycle function to restart.

NOTE

The ramp cannot return to zero if the LOWER LIMIT is set above zero; or if the UPPER LIMIT is set below zero.

2.3.6 X100 (OPTION D)

To use the X100 count multiplier, a second count divider circuit must be installed (see figure 2–11), and the jumpers must be connected from E48 to E49 and from E51 to E52. The counter is operated in the normal manner, except that every one hundredth event is counted, which increases the counters capacity to 9,999,900 (1kHz).

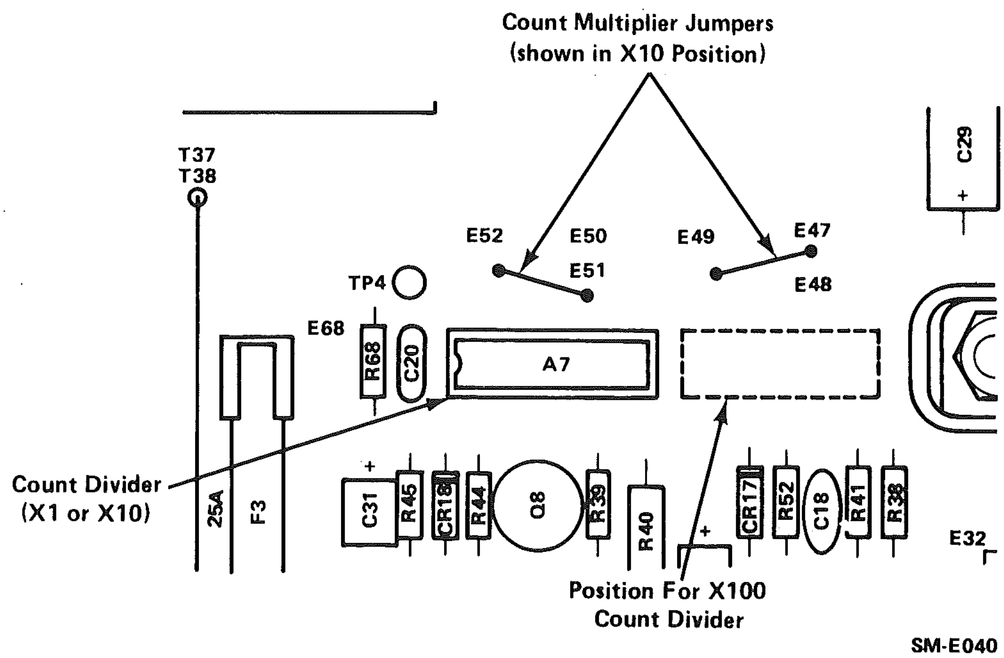

Figure 2-11. X100 (Option D) - Count Multiplier Jumpers and Count Divider

SECTION III
SERVICE

The 436.11 Control Unit and option D (X100 counter) do not require calibration. Option A (soft run/stop), option B (function generator) and option C (ramp generator), require specific calibration procedures and adjustments as noted in the following discussion.

3.1 SOFT RUN/STOP (OPTION A)

3.1.1 ZERO, X OFFSET, Y OFFSET, and GAIN Adjustments

Calibrate the ZERO, X OFFSET, Y OFFSET and GAIN functions by making the following adjustments:

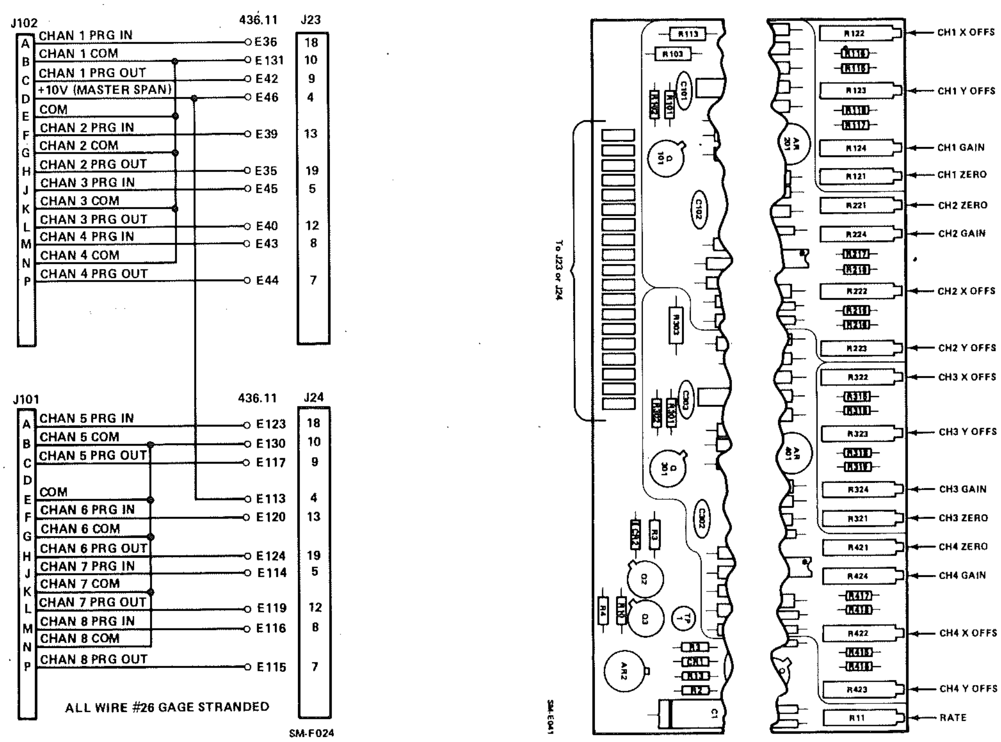

Figure 3-1. Soft Run/Stop Adjustments

1. Connect a jumper to J101 or J102 (see figure 3-1) between COMMON and PROGRAM IN for the first channel to be calibrated.

2. Set PROGRAM STOP on the control unit.

3. Adjust the appropriate ZERO potentiometer, on the program conditioner circuit card, to obtain a reading of 0.0 Vdc, ±2 mV at the applicable PROGRAM OUT pin on J101 or J102.

4. Set PROGRAM RUN on the control unit.

5. Adjust the appropriate X OFFSET potentiometer, on the program conditioner circuit card, to obtain a reading of 0.0 Vdc ±5 mV, at the applicable PROGRAM OUT pin on J101 or J102.

6. Repeat steps 2 and 3.

7. Remove the jumper installed in step 1.

8. Connect a jumper to J102 between a COMMON and +10V (MASTER SPAN).

9. Apply a 20 Vp-p, 100 Hz sine wave to the applicable PROGRAM IN pin on J101 or J102.

10. Set PROGRAM RUN on the control unit.

11. Adjust the appropriate Y OFFSET potentiometer, on the program conditioner circuit card, to obtain the lowest possible ac voltage (less than 50 mVp-p) at the applicable PROGRAM OUT pin on J101 or J102.

12. Remove the jumper installed in step 8.

13. Apply +10.00 Vdc, ±2 mV to the +10V (MASTER SPAN) pin on J102.

14. Apply +10.00 Vdc, ±2 mV to the applicable PROGRAM IN pin on J101 or J102.

15. Adjust the appropriate GAIN potentiometer, on the program conditioner circuit card, to obtain a reading of +10.00 Vdc, ±10 mV at the applicable PROGRAM OUT pin on J101 or J102.

16. Repeat steps 1 through 15 to verify that no further adjustment is necessary.

17. Perform steps 1 through 16 for all of the remaining channels.

3.1.2 RATE Adjustment

Adjustment of the RATE potentiometer is discussed in paragraph 2.3.3.

3.2 FUNCTION GENERATOR (OPTION B)

Calibrate the function generator as follows:

1. Depress PROGRAM STOP on the control unit.

2. Connect a digital voltmeter to TP1 (red) and the common jack on the front panel and adjust R44 (see figure 3-2) for +10.00 Vdc, ±2 mV.

3. Connect the voltmeter to TP2 (white) and adjust R48 for -10.00 Vdc, ±2 mV.

4. Set the frequency range selector to 10-110 and the FREQUENCY dial to 100 (10 Hz).

5. Select the square waveform.

6. Connect an oscilloscope to the output jacks on the front panel. (An electronic counter can be used for more accurate adjustment if desired).

7. Depress PROGRAM RUN on the control unit.

8. Adjust R28 (symmetry trimmer) for a symmetrical square wave measured at the output jacks.

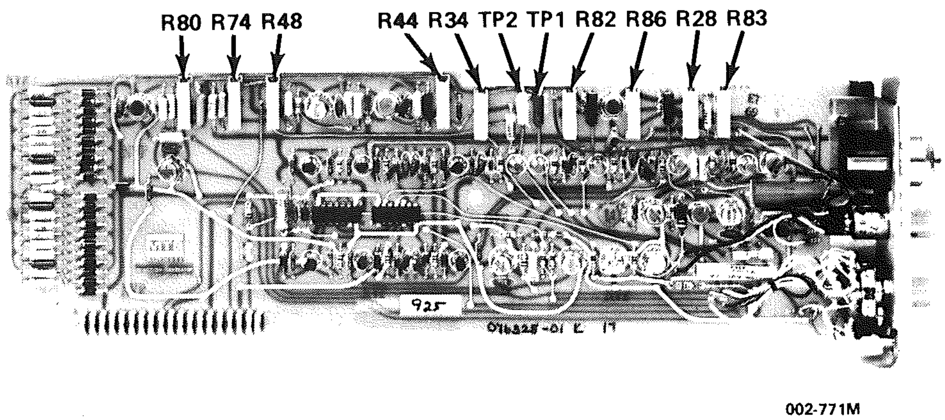

Figure 3-2. Function Generator (Option B) - Calibration Adjustments

9. With the function generator running and the electronic counter connected to the output jacks, select a frequency of 110 Hz (10-110 range) and adjust R82 (upper frequency trimmer) for a period of 9.09 msec.

10. Select a frequency of 10 Hz (10-110 range) and adjust R83 (lower frequency trimmer) for a period of 100.00 msec or 10 Hz.

11. To eliminate the effects of interaction between R82 and R83, repeat steps 8 and 9 until an accuracy of ±0.1% is obtained for each step.

12. Select a frequency of 1100 Hz and adjust R86 (high frequency trimmer) for a period of 0.9091 msec measured at the output tip jack.

13. Depress PROGRAM STOP on the control unit.

14. Select a frequency of 100 Hz and the triangle waveform.

15. Connect the voltmeter to the output jacks.

16. Adjust R34 (non-run dc level trimmer) for an output of 0.000 volts, ±2 mV.

17. Select the sine waveform and adjust R74 (sine zero trimmer) for an output of 0.000 volts, ±2 mV.

18. Depress PROGRAM RUN on the control unit.

19. Using the oscilloscope and an amplitude measurement unit (such as the MTS Model 440.51), adjust R80 (sine gain trimmer) for sine wave peaks of 10.000 volts, ±10 mV at the output.

20. Depress PROGRAM STOP on the control unit.

3.3 RAMP GENERATOR (OPTION C)

Calibration of the ramp generator consists of adjusting the VCO ZERO and VCO GAIN of the voltage controlled oscillator (VCO) and adjusting the OUTZERO of the ramp output.

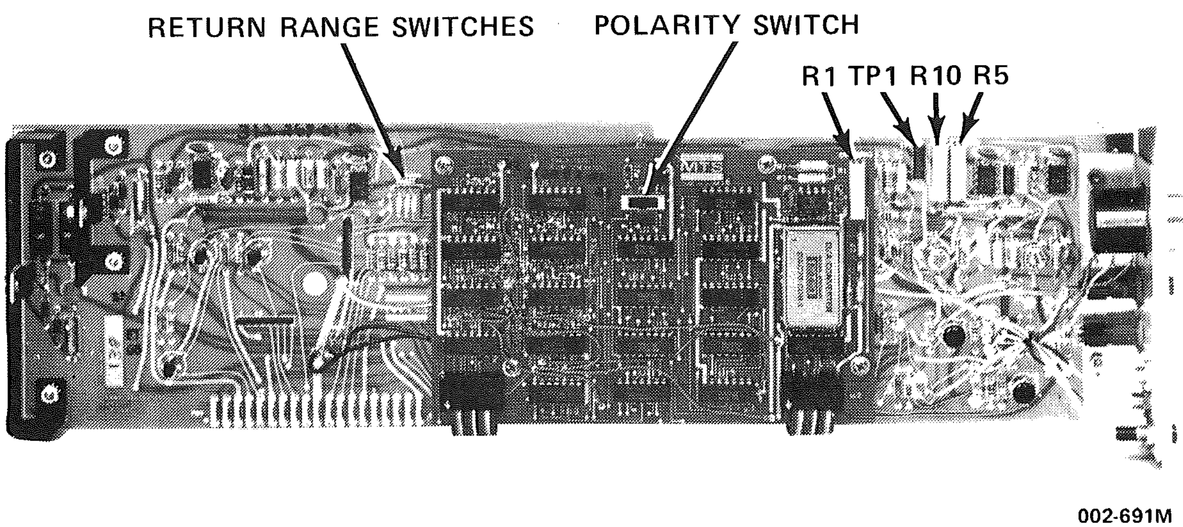

Figure 3-3. Ramp Generator (Option C) - Test Point And Calibration Controls

3.3.1 VCO ZERO Adjustment

1. Slide the 436.11 Control Unit as far out of the console as necessary to gain access to test point TP1 (see figure 3-3) and variable resistors R1, R5, and R10.

2. Connect an oscilloscope to TP1.

3. Select 1K on the RATE RANGE switch on the remote test control unit.

4. Adjust and lock the RATE control on the front panel fully counterclockwise (0.00).

5. Adjust R5 (VCO ZERO) counterclockwise until the signal at TP1 begins to oscillate slowly.

6. Readjust R5 (VCO ZERO) clockwise until the voltage at TP1 remains nearly constant (not in negative saturation) -13 to -15 Vdc.

3.3.2 VCO GAIN Adjustment

1. Adjust the RATE control to 1000.

2. Set the RATE RANGE switch on the remote test control unit to 10.

3. Connect a frequency counter to the VCO test jack on the module front panel.

4. Adjust R10 (VCO GAIN) for a frequency of 13.107, ±0.002 kHz.

3.3.3 RAMP OUTZERO Adjustment

1. Press RETURN on the remote test control unit. Ensure that the OUTPUT AT ZERO indicator on the module front panel is lit.

2. Connect a digital voltmeter to the RAMP test jack on the module front panel.

3. Adjust R1 (OUTZERO) for 0.000, ±0.001 Vdc. See figure 3-3.

4. Disconnect all leads and slide the control unit back into the console.

SECTION IV
INSTALLATION

This section contains instructions for making the appropriate power, ground, and system connections to the 436.11 Control Unit and its four options.

4.1 CONTROL UNIT

The following paragraphs describe the installation procedures for the control unit.

4.1.1 ELECTRICAL POWER CONNECTIONS

The 436.11 Control Unit receives ac power from its permanent 3-wire power cord. The power ground wire of the cord is connected to the 436.11 chassis (green terminal on the rear panel; see figure 4-1). Unless otherwise specified, the 436.11 comes wired for a line supply of 105-125 Vac, 50/60 Hz.

4.1.1.1 Changes to Accommodate 210-250 Vac Line Supply

1. The two primary windings of the 436.11 power transformer must be connected in series by changing the jumper wire placement at terminals E99, E101, E102, and E103. These terminals are located on the main printed circuit card, inside the unit, just below the main power transformer. If it is necessary to move the power transformer to gain access to the terminals, remove the four screws which hold the transformer to the side of the chassis and set the transformer aside. Do not disconnect the transformer leads.

2. Remove the jumpers from terminals E99 to E102, and E101 to E103.

3. Connect a jumper from terminal E101 to E102.

4. Replace the 3/4A, 115 V fuse in fuseholder F1, on the rear panel, with a 3/8A, 230 V fuse. Do not change fuse F2.

5. Replace the MTS 100880-02 power cord connector with an MTS 100880-05 connector.

6. Replace the MTS 100917-01 accessory receptacle, on the rear panel, with an MTS 100917–02 receptacle.

4.1.1.2 Changes to Accommodate 105-125 Vac Line Supply

1. The two primary windings of the 436.11 power transformer must be connected in parallel by changing the jumper wire placement at terminals E99, E101, E102, and E103. These terminals are located on the main printed circuit card inside the unit, just below the power transformer. If it is necessary to move the power transformer to gain access to the terminals, remove the four screws which hold the transformer to the side of the chassis and set the transformer aside. Do not disconnect the transformer leads.

2. Remove the jumper from terminal E101 to E102.

3. Connect jumpers from terminals E99 to E102, and E101 to E103.

4. Replace the 3/8A, 230 V fuse in fuseholder F1, on the rear panel, with a 3/4A, 115 V fuse. Do not change fuse F2.

5. Replace the MTS 100880-05 power cord connector with an MTS 100880-02 connector.

6. Replace the MTS 100917-02 accessory receptacle, on the rear panel, with an MTS 100917-01 receptacle.

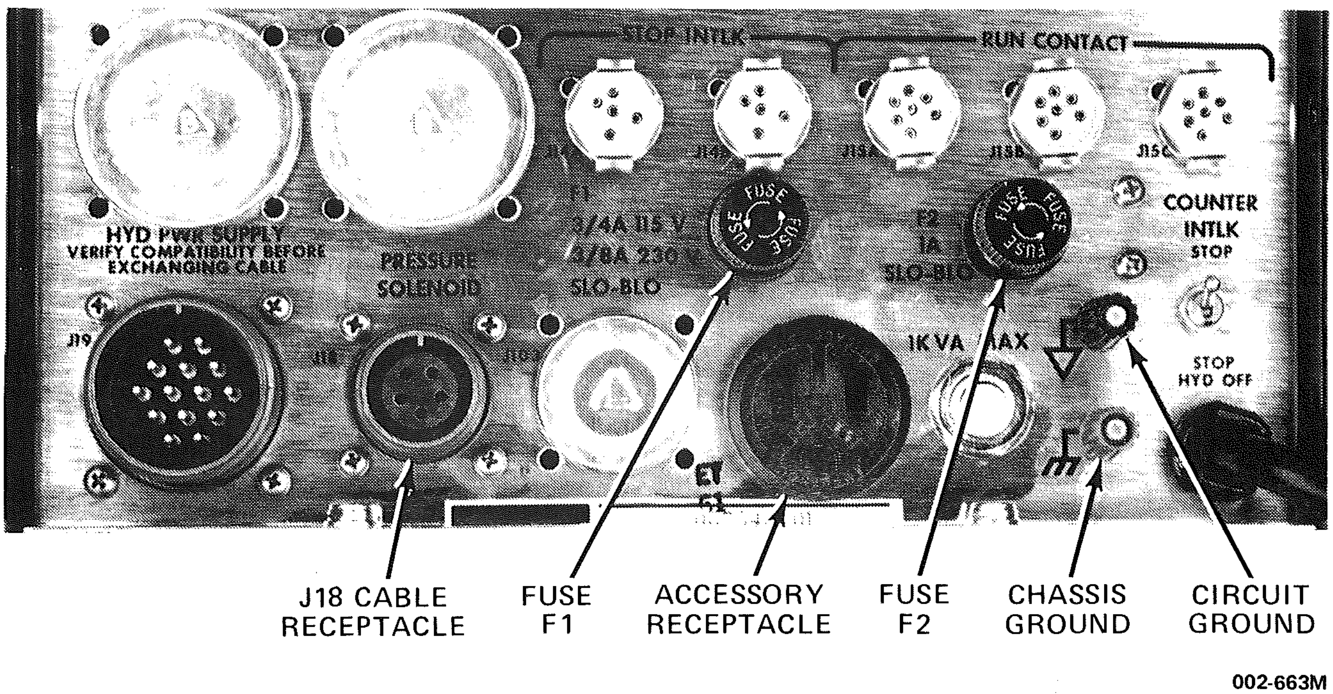

Figure 4-1. Control Unit - Rear Panel

4.1.2 RACK MOUNTING (OPTIONAL)

The 436.11 Control Units can be mounted singly, side-by-side, or side-by-side with a 406.11 Controller in any Standard 19 inch RETMA®-type rack with Unistrut™ type construction or standard EIA hole spacing. Figure 4-2 shows typical installation of a single control unit using Unistrut type construction. Figure 4-3 shows side-by-side installation of two control units or a control unit and a controller using EIA spaced holes.

The front panel mounting hardware for single installation (including a blank panel to fill the space to the right of the control unit) is contained in kit B064985-02. Double mounting hardware is contained in kit B064985-02.

4.1.3 SYSTEM COMMON AND GROUND CONNECTIONS

Figure 4-1 shows the external connections for signal common (black terminal) and electrical power ground (green terminal). The green terminal is connected to the 436.11 chassis. Correct grounding of the signal common is important for minimum signal noise.

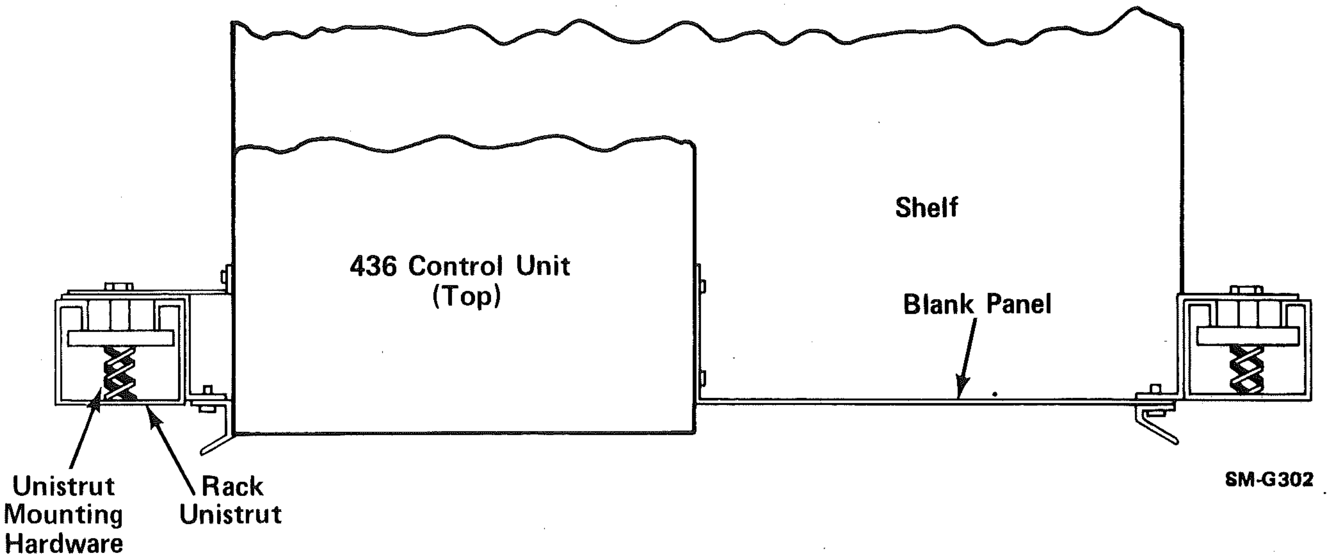

Figure 4-2. Single Control Unit Mounting Using Unistrut Hardware

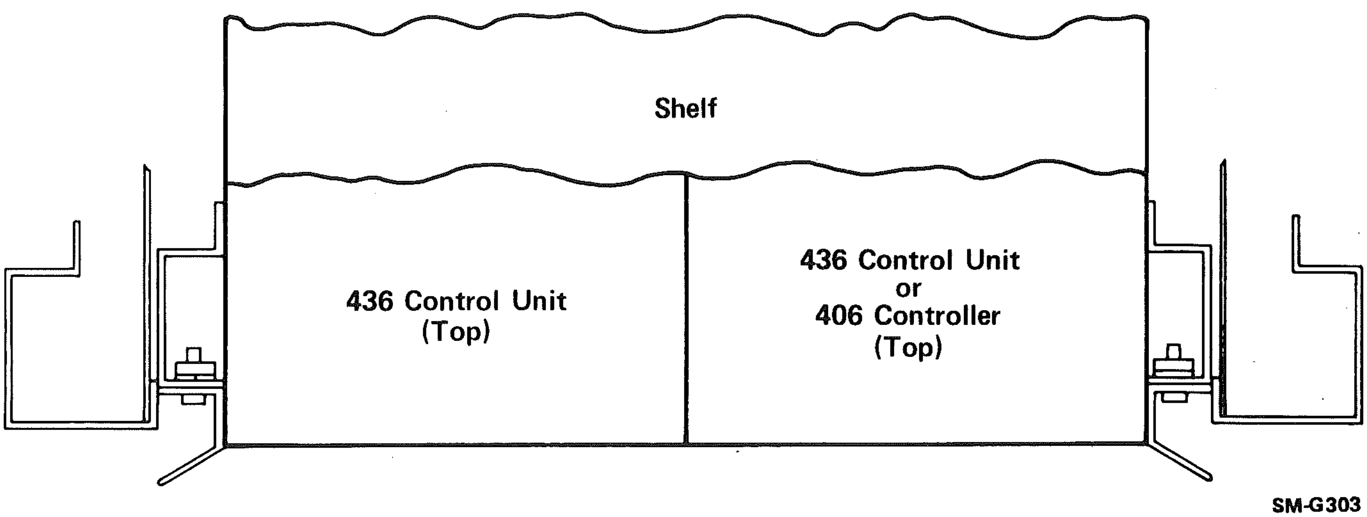

Figure 4-3. Double Control Unit or Control Unit and Controller Mounting Using EIA Spaced Holes

4.1.3.1 Single Channel

For systems using one 436.11 Control Unit, connect a jumper from the black to the green terminal.

4.1.3.2 MULTIPLE CHANNEL

For systems using more than one control unit, three grounding methods are commonly used:

1. If the building electrical power ground is very good, connecting a jumper from the black to the green terminal on each control unit may be satisfactory.

2. A better method is to connect the black terminals on all control units together with a number 8 or 10 wire and connect this wire to a single power ground point located, for example, in a power entrance panel. In some cases, a single earth ground point may be advantageous.

3. The best method is to connect a separate number 8 or 10 wire from each black terminal on each control unit to a single power ground or earth ground point.

4.1.4 HYDRAULIC POWER SUPPLY CONNECTIONS

Jack J19 on the rear panel of the 436.11 has connections for controlling the hydraulic power supply from the control unit when the power supply is connected for remote operation.

Figure 4-4 shows a cable containing connections for the ON, LOW PRESSURE, HIGH PRESSURE, and OFF functions of a typical hydraulic power supply.

Typical MTS hydraulic supply cables use 18 AWG conductors with a 600 volt type SO Neoprene jacket (Western Wire and Cable type Bronco 66 or equivalent).

NOTE

> In systems using MTS Hydraulic Service Manifold Models 284.X5 and 284.X6, the LOW PRESSURE and HIGH PRESSURE functions are controlled at the service manifold through J18 rather than at the hydraulic power supply. Connect a jumper between pins E88 and E90 on the main printed circuit board so that the hydraulic supply will come up to high pressure immediately upon being turned on. For operating information using this configuration, see paragraph 2.3.1.4.

4.1.5 PRESSURE SOLENOID CONNECTIONS

Jack J18 on the rear panel of the 436.11 (figure 4-1) is used only in systems having hydraulic service manifolds with one or two solenoid valves.

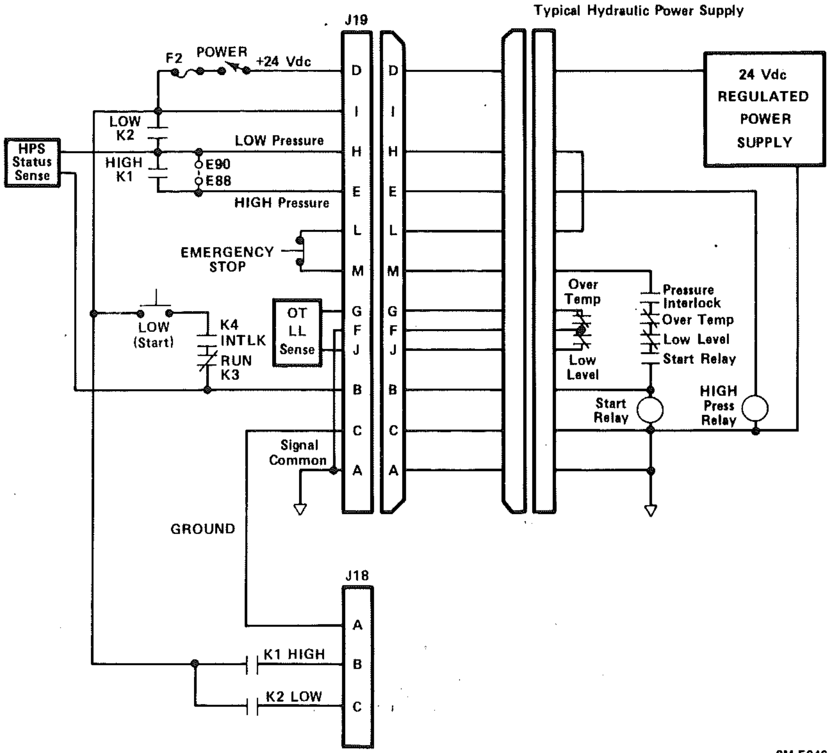

Figure 4-4. Recommended Hydraulic Power Supply Connections

Typical MTS pressure solenoid cables use 18 AWG conductors with a 600 volt type SO Neoprene jacket (Western Wire and Cable type Bronco 66 or equivalent).

4.1.5.1 Single Pressure Solenoid (Type 3 System)

Hydraulic service manifolds with a single solenoid valve which simply opens and closes the high pressure line to the servovalve, are models 284.X3 and 284.X4. Figure 4-5 shows recommended cabling for this configuration. For operating information using this configuration, see paragraph 2.3.1.3.

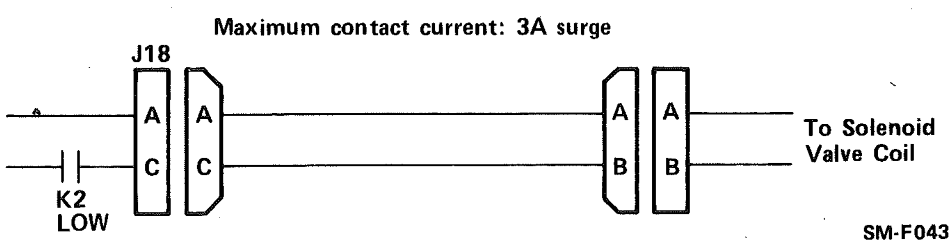

Figure 4-5. Recommended Single Pressure Solenoid Cable

4.1.5.2 Double Pressure Solenoid (Type 4 System)

Hydraulic service manifolds with double solenoid valves which provide OFF, LOW, and HIGH pressure control, are models 284.X5 and 284.X6. Figure 4-6 shows the recommended cabling for this configuration. For operating information using this configuration, see paragraph 2.3.1.4.

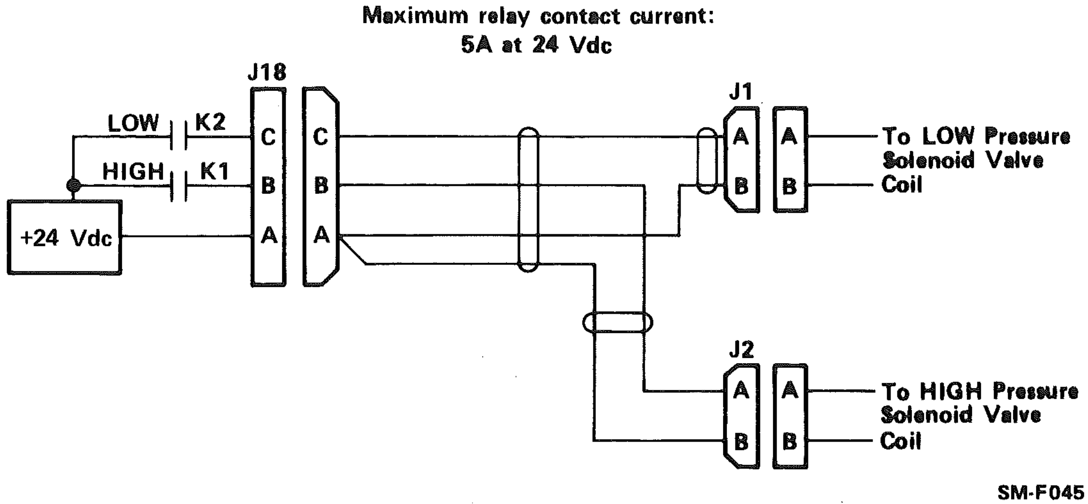

Figure 4-6. Recommended Double Pressure Solenoid Cable

4.1.6 STOP/HYD OFF INTLK CONNECTIONS

Jacks J13A through J13D on the rear panel have connections for cabling to external sensors, such as travel limit switches on an actuator, the interlock circuits on the 406.11 Controller, etc.

An open interlock anywhere in this circuit causes the program to stop and hydraulic pressure to be removed. The interlock operates on 26 Vdc. If this source is accidentally shorted, fuse F3 (0.25A) located on the main printed circuit board inside the 436 will open.

Figure 4-7 shows an example of two cables running to separate limit switches positioned to open if actuator stroke exceeds a desired limit in either direction. Any normally-closed sensor may be connected into the interlock in this way. A jumper plug, as shown on J13D and J13A, must be connected to any jack not used.

For cabling to J13 from the 406.11 interlock circuits (J301, pins E and H), see the 406 installation instructions.

Typical MTS interlock cables use 18 AWG conductors with a 600 volt type SO Neoprene jacket (Western Wire and Cable type Bronco 66 or equivalent) for connection to distant devices such as limit switches on a hydraulic actuator. For connection to an electronic unit located in the same console, a stranded 22 to 26 AWG twisted pair is adequate.

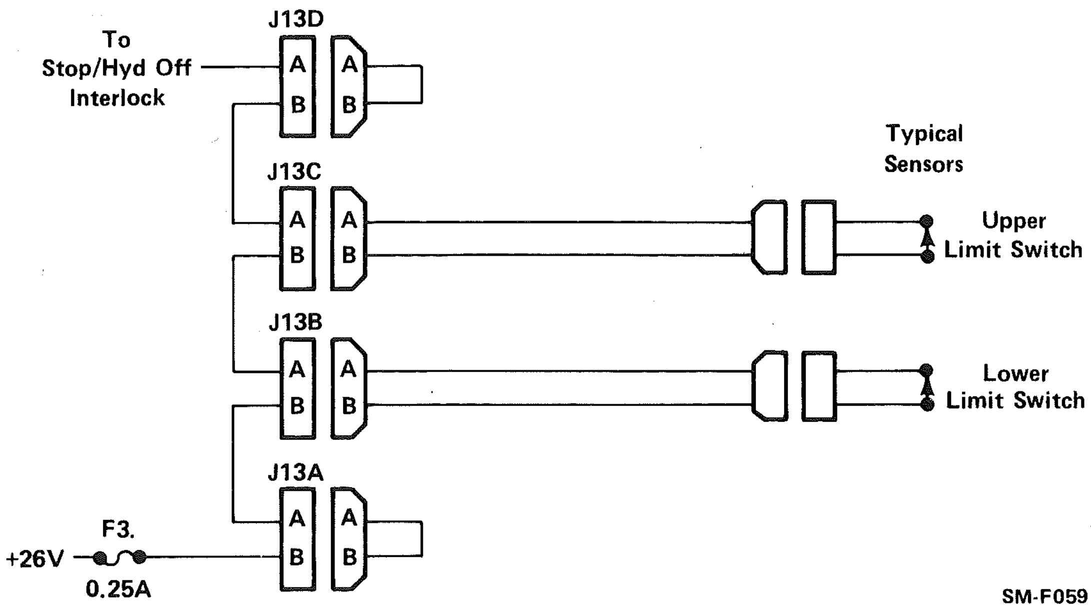

Figure 4-7. Recommended Stop/Hyd Off Interlock Cables

4.1.7 STOP INTLK CONNECTIONS

Jacks J14A and J14B on the rear panel have connections for cabling to external sensors or other switches or relay contacts. A typical example is the "crosshead unlock" switch on load frames equipped with hydraulic crosshead locks.

An open interlock anywhere in this circuit causes the program to stop. Hydraulic pressure is not removed; any static load command (SET POINT, etc.) will remain active.

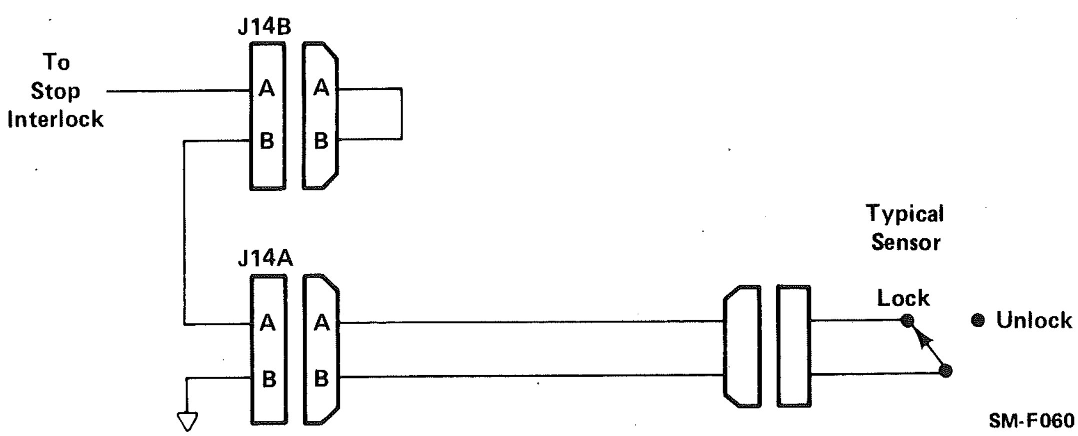

Figure 4-8. Recommended Stop Interlock Cable

Figure 4-8 shows an example of a cable to a set of contacts on the LOCK/UNLOCK switch mounted on an MTS load frame with hydraulic crosshead locks. If the switch is not in the LOCK position, the operator will not be able to start the program. Any normally-closed sensor may be connected into the interlock in this way. A jumper plug as shown on J14B must be connected to any jack not used.

Typical MTS interlock cables use 18 AWG conductors with a 600 volt type SO Neoprene jacket (Western Wire and Cable type Bronco 66 or equivalent) for connection to distant devices such as the LOCK/UNLOCK switch on a load frame. For connection to an electronic unit located in the same console, a stranded 22 to 26 AWG twisted pair is adequate.

4.1.8 HYD CONTACT CONNECTIONS

Jack J16, on the rear panel, is connected to contacts of a relay within the 436.11. The contacts are energized when LOW hydraulic pressure is applied. These connections can be used to indicate whether low pressure is off or on, to remotely located personnel or external equipment.

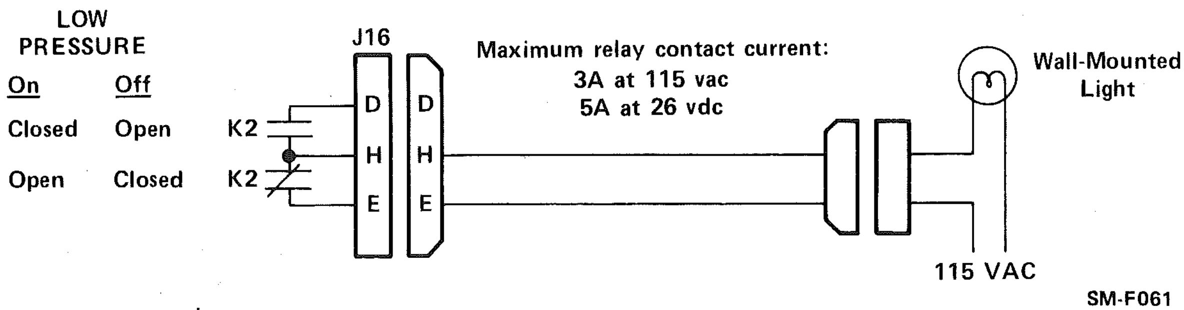

Figure 4-9. Recommended Low Pressure Contact Cable

Figure 4-9 shows an example of a warning light designed to alert an operator working in another room that the system has shut down because the stop/hydraulic off interlock has opened. An audible alarm or other device could be connected in the same way. The other K2 contacts shown are available if some device (for example, a system running time meter used to keep track of maintenance intervals) is to be turned off when hydraulic pressure is off.

4.1.9 HIGH CONTACT CONNECTIONS

Jack J20 on the rear panel is connected to contacts of a relay within the 436.11 that is energized to apply HIGH hydraulic pressure. These connections can be used to indicate to external equipment whether high pressure is off or on.

Figure 4-10 is an example of use of contacts for an interlock function. A 406.11 Controller equipped with option C has an integrator circuit that should not be turned on until after low pressure is applied . The connection shown ensures that the integrator cannot be on as low pressure is applied since (in most systems) the high relay does not energize until after low pressure is applied. This connection provides an automatic on-off function.

NIFTY

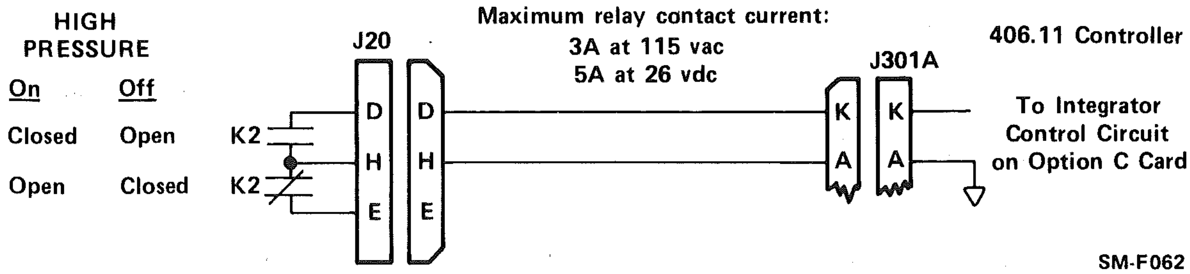

Figure 4-10. Recommended High Pressure Contact Cable

4.1.10 RUN CONTACT CONNECTIONS

Jacks J15A through J15C on the rear panel have connections for three separate functions, all associated with the RUN/STOP conditions of the 436.11. Figure 4-11 shows cables containing the three typical uses of the J15 jacks described below.

1. Contacts for automatically starting and stopping external devices, such as recorders, with the program (figure 4-11, J15A).

2. A positive voltage and contacts for automatically gating an external function generator on RUN and stopping it on STOP (Figure 4-11, J15B). Note: This function is not used if either the program soft run/stop option or the internal function generator option is supplied with the 436.11.

3. Contacts for interconnecting the RUN buttons on up to ten 436.11 Control Units so that any control unit can start (but not stop) the test run (figure 4-11, J15C).

Figure 4-11 shows a cable containing the three typical uses of the J15 jacks described above.

Typical MTS cables use a stranded 22 to 26 AWG twisted pair.

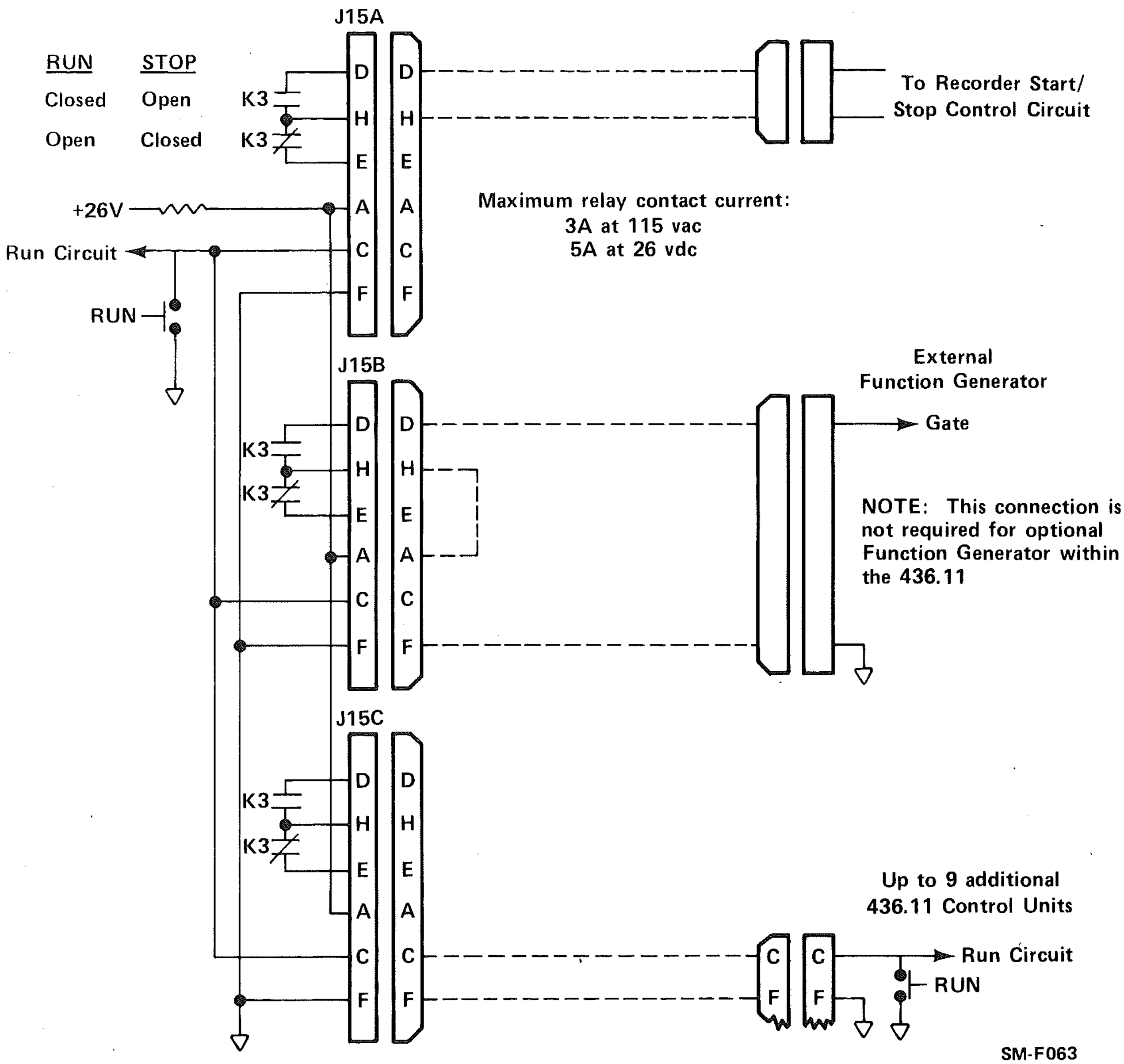

Figure 4-11. Recommended Run Contact Cable (Composite)

4.1.11 COUNTER INPUT CONNECTIONS

Jacks J21 and J22 on the rear panel provide connections to the counter from a programmer and external source, respectively.

NOTE

If the 436.11 is supplied with either the program soft run/stop option or the internal function generator option, the illustration for J21 below does not apply. See paragraph 4.2 for program soft run/stop connections or paragraph 4.3 for internal function generator connections.

Figure 4-12 shows cables for counter inputs from two different programmer types.

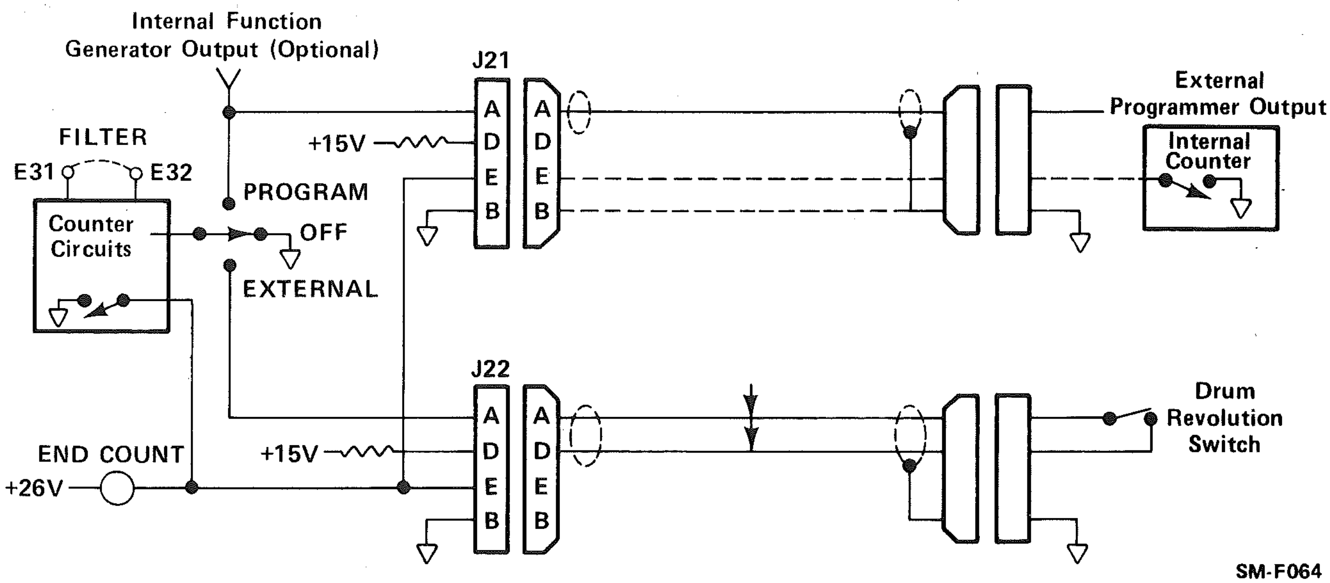

Figure 4-12. Recommended Counter Input Cables

A conventional function generator or low frequency oscillator is shown connected to J21. The dotted lines indicate optional connections that can be used to connect the programmer's own counter and end of count contacts (if any) to light the END COUNT indicator on the 436.11. With this arrangement, the 436.11 counter can be set to count external events at the same time that the programmer is counting its own cycles. Whichever reaches its pre-set count first lights END COUNT. The connections shown by dotted lines are not used if the programmer has no end of count contacts.

A curve following programmer with a microswitch that closes once for each revolution of the drum is shown connected to J22. Because mechanical contacts produce "bounce" noise that may interfere with counter operation, an input filter circuit is provided. To include the filter, connect a jumper between E31 and E32 in the middle of the main printed circuit board. The jumper should be removed when counting programmer cycles above 1 Hz since it will limit counter frequency response.

Typical MTS counter input cables use RG-58 coaxial cable for function generator-type programmers and a stranded 22 AWG twisted pair with shield (Belden type 8737 or equivalent) for inputs from mechanical contacts.

4.2 SOFT RUN/STOP (OPTION A)

On control units equipped with the soft run/stop option, jack(s) J102 (and if required, J101) on the rear panel provide connections for programmer input, soft-start program output, and master span control of program amplitude to all channels.

Figure 4-13 shows a cable containing connections for a single channel of soft run/stop control plus an input to the 436.11 counter (J21). The dotted lines indicate optional connections for a remote master span control that determines the amplitude of the dynamic command to all eight channels simultaneously. If a master span control is not used, a wire must be connected directly from J102, pin D to J300A, pin E.

The remaining pins of J102 and all of the pins of J101 (if supplied) are for similar soft run/stop connections to additional channels.

Additional connections to J300A on the 406.11 (if desired) are described in the 406.11 manual.

The cable shown in Figure 4-13 (MTS number A068622) uses RG58 coaxial cable for the programmer signal and stranded 22 AWG twisted pairs for the other connections. For long runs between the 406.11 and 436.11, a stranded 22 AWG twisted pair with shield (Belden type 8737 or equivalent) is recommended.

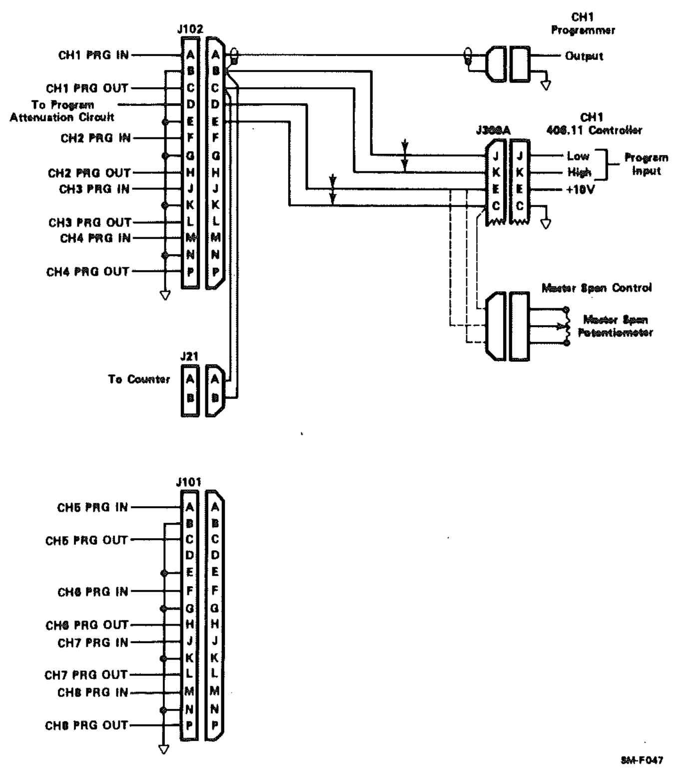

Figure 4-13. Recommended Soft Run/Stop (Option A) Cable

NOTE

Installation of option A must be accomplished at the factory. For information, contact the Customer Service Division, MTS Systems Corporation.

4.3 FUNCTION GENERATOR (OPTION B)

Installation of the function generator requires that the 436.11 Control Unit be modified, and that a cable be connected from the function generator to the 406.11 Controller.

4.3.1 MODIFYING THE CONTROL UNIT

Modify the control unit by connecting a wire from E118 to E93 (see figure 4-14) on the control unit master printed circuit board, using the crimp type terminals (MTS Part Number 100825-02) provided with the function generator kit to make the connections.

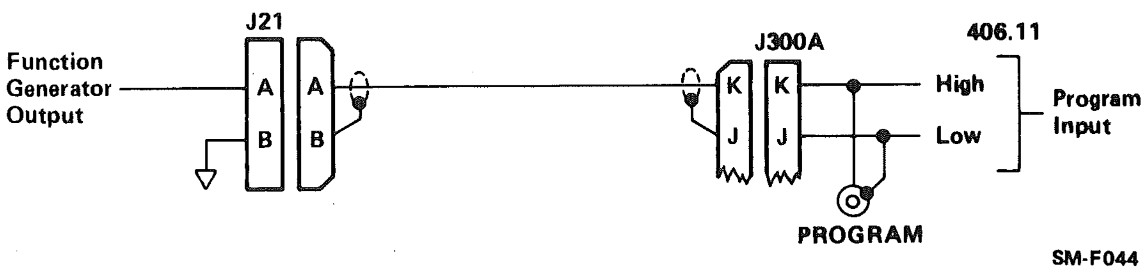

Figure 4-14. Control Unit - Modification and Function Generator Cabling

4.3.2 INSTALLING THE FUNCTION GENERATOR

Install the function generator as follows:

1. With power off, slide the control unit out of the console as far as the mounting will permit.

2. Insert the function generator into the right side of the control unit and carefully mate it to J24, located along the right side of the main circuit board.

3. Secure the function generator to the control unit by installing the attaching hardware provided with the function generator kit.

4. Slide the control unit back into the console.

4.3.3 FUNCTION GENERATOR TO CONTROLLER CONNECTIONS

The function generator output must be connected to the 406.11 Controller. Jack J21 (which is the counter input jack for a separate function generator) is used as the program output of the internal function generator. Connect a cable from J21 to J300A (see figure 4-14). Typical MTS function generator cable is RG-58 coaxial cable. A stranded 22 AWG twisted pair with shield (Belden type 8737 or equivalent) is also adequate.

4.3.4 REPLACING A RAMP GENERATOR WITH A FUNCTION GENERATOR

1. Disconnect the ramp generator remote test control cable A054058-XX from J101 on the control unit.

2. With power off, slide the control unit out of the console as far as the mounting will permit.

3. Remove the ramp generator attaching hardware.

4. Carefully separate the ramp generator from J24 and remove it from the control unit.

5. Connect a jumper wire between pins N and P on a connector compatible with J101. Install the jumper equipped connector on J101.

6. Insert the function generator into the right side of the control unit and carefully mate it to J24.

7. Secure the function generator to the control unit by installing the attaching hardware provided with the function generator kit.

8. Slide the control unit back into the console.

9. Make the cable connections specified in paragraph 4.3.3.

4.4 RAMP GENERATOR (OPTION C)

Installation of the ramp generator consists of modifying the control unit and installing the ramp generator (MTS 436.11 Ramp Generator Modification Kit Part Number 313151-01).

4.4.1 MODIFYING THE CONTROL UNIT

Modify the control unit as follows:

1. With power off, slide the control unit out of the console as far as the mounting will permit.

2. Remove the wire from E10 (on the control unit main printed circuit board) to pin B of J13A.

3. Install connector J101 on the rear panel of the control unit.

4. Connect a wire (no. 22 AWG stranded) from pin A of J101 to the + terminal of BR-2 (on the control unit master printed circuit board).

5. Connect a wire (no. 20 AWG stranded) from pin B of J101 to terminal E130 using MTS crimp-on terminal Part Number 100825-02.

6. Connect a wire (no. 24 or 26 AWG stranded) from pin C of J101 to terminal E117.

7. Connect a wire (no. 24 or 26 AWG stranded) from pin D of J101 to terminal E116.

8. Connect a wire (no. 24 or 26 AWG stranded) from pin E of J101 to terminal E115.

9. Connect a wire (no. 24 or 26 AWG stranded) from pin G of J101 to terminal E119.

10. Connect a wire (no. 24 or 26 AWG stranded) from pin H of J101 to terminal E120.

11. Connect a wire (no. 24 or 26 AWG stranded) from pin K of J101 to terminal E121.

12. Connect a wire (no. 24 or 26 AWG stranded) from pin L of J101 to terminal E122.

13. Connect a wire (no. 24 or 26 AWG stranded) from pin M of J101 to terminal E114.

14. Connect a wire (no. 24 or 26 AWG stranded) from pin N of J101 to terminal E10.

15. Connect a wire (no. 24 or 26 AWG stranded) from pin P of J101 to pin B of J13A.

16. Connect wires (no. 24 or 26 AWG stranded) from pins J to B and B to F on J101 (this may have been done by MTS).

17. Connect a wire (no. 24 or 26 AWG stranded) from terminal E118 to E93 (if the control unit was equipped with a function generator, this step has already been performed).

4.4.2 INSTALLING THE RAMP GENERATOR

Install the ramp generator as follows:

1. Insert the ramp generator into the right side of the control unit and carefully mate it to J24.

2. Secure the ramp generator to the control unit by installing the attaching hardware provided with the ramp generator kit.

3. Connect cable A054058-XX from the ramp generator remote test control to J101 on the control unit.

4. Slide the control unit back into the console.

4.4.3 REPLACING A FUNCTION GENERATOR WITH A RAMP GENERATOR

1. Remove the jumpered connector from J101 on the control unit (if one is installed).

2. Remove the function generator attaching hardware.

3. Carefully separate the function generator from J24 and remove it from the control unit.

4. If the control unit has not been previously modified to accommodate a ramp generator, perform the procedures in paragraph 4.4.1.

5. Install the ramp generator according to the procedures in paragraph 4.4.2.

4.5 X100 COUNTER CAPACITY (OPTION D)

Paragraph 2.3.6 provides all of the necessary information needed to install Option D, except that a 16 pin DIP socket for the second count divider must be installed at the location indicated in figure 2-11.

4.6 CONTROL VOLTAGE MODIFICATION

The 436.11B Control Unit is equipped to control a hydraulic power supply (HPS), hydraulic service manifold (HSM) and servovalve using 24 Vdc relay/solenoid voltage derived from the HPS. Conversion kits 334349-01 and 334349-02 are available from MTS Systems for changing this voltage. Kit 334349-02 is used to convert from 24 Vdc to 115 Vac operation, while kit 334349-01 enables modification of a 436.11A Control Unit to control 24 Vdc equipped devices.

4.6.1 MODIFICATION OF 436.11B UNITS FROM 24 VDC TO 115 VAC CONTROL OPERATION

CAUTION

Conversion of the 436.11 relay/solenoid driving voltage requires that corresponding changes or new equipment be installed elsewhere in the system to prevent equipment damage. These areas include the hydraulic power supply, load frame crosshead locks and the hydraulic service manifold.

To convert a 436.11B to control 115 Vac operated devices, kit 334349-02 should be installed as follows:

1. Remove fuse F2 from the holder on the back panel and replace it with MTS part number 100527-12 (2.8 amp slo-blo fuse).
2. Remove diodes CR41 and CR42 from control unit back panel cable receptacle J18 pins A, B, and C.
3. Remove all wires connected to receptacle J18, pin number tagging each wire as it is removed.
4. Remove J18 from the rear panel and replace it with part number 100419-34.
5. Re-attach all wires to J18. Observe the tag marking to ensure connection to the correct pins.
6. Remove all wires connected to back panel receptacle J19, tagging each wire as it is removed. Remove diode CR40 from pins F and G, tagging each lead.

7. Remove J19 from the rear panel and replace it with part number 100419-25.

8. Re-attach all wires to J19. Observe the tag markings to ensure connection to the correct pins. Re-attach diode CR40, ensuring that the leads are connected to the proper pins.

9. As observed from the front panel, lay the control unit on its left side and remove the bottom sheet metal panel.

10. Remove transformer T1 (attached to the left side of the unit) and set it aside. Do not disconnect the transformer leads.

11. Remove resistors R54 and R70 (located near the rear edge of the main circuit board near the two large capacitors).

12. Replace R54 and R70 with part number 100016-20 (100 k).

13. Replace T1.

14. Replace the bottom sheet metal panel.

4.6.2 MODIFICATION OF 436.11A UNITS FROM 115 VAC to 24 VDC CONTROL OPERATION

CAUTION

Conversion of the 436.11 relay/solenoid driving voltage requires that corresponding changes of new equipment be installed elsewhere in the system to prevent equipment damage. These areas include the hydraulic power supply, load frame crosshead locks and the hydraulic service manifold.

To convert a 436.11A to control 24 Vdc operated devices, kit 334349-01 should be installed as follows:

1. Remove fuse F2 from the holder on the back panel and replace it with MTS part number 100527-28 (5 amp slo-blo fuse).

2. Remove all wires connected to back panel cable receptacle J18, pin number tagging each wire as it is removed.

3. Remove J18 from the rear panel and replace it with part number 100419-07.

4. Re-attach all wires to J18. Observe the tag markings to ensure connection to the correct pins. When connecting lead A, also connect the anode leads of CR41 and CR42 (part number 100086-04) to pin A. When connecting lead B, also connect the cathode (silver band end) lead of one diode to pin B. When connecting lead C, also connect the cathode lead of the second diode to pin C.

5. Remove all wires connected to receptacle J19, tagging each wire as it is removed. Remove diode CR40 from pins F and G, tagging each lead.

6. Remove J19 from the rear panel and replace it with part number 113393-10.

7. Re-attach all wires to J19. Observe the tag markings to ensure connection to the correct pins. Reattach diode CR40, ensuring that the leads are connected to the proper terminals.

8. As observed from the front panel, lay the control unit on its left side and remove the bottom sheet metal panel.

9. Remove transformer T1 (attached to the left side of the unit) and set it aside. Do not disconnect the transformer leads.

10. Remove resistors R54 and R70 (located near the rear edge of the main circuit board near the two large capacitors).

11. Replace R54 and R70 with part number 100086-04 (30 K).

12. Replace T1.

13. Replace the bottom sheet metal panel.

SECTION V
THEORY OF OPERATION

5.1 CONTROL UNIT

5.1.1 HYDRAULIC CONTROL LOGIC

Hydraulic control (see schematic number 337088-01) begins with the interlock chain (J13). Fuse linked 26 volts is supplied through all of the connector J13 pins A to B for relay excitation.

When relay K2 is energized, a contact across the LOW push button S1A latches K2 until the interlock chain is interrupted. The K3 (RUN) contact in series with the LOW push button S1A prevents hydraulic turn-on while the unit is in RUN. The HYD INTLK push button bypasses the J13 interlocks enabling the operator to override an interlock condition and turn on the hydraulics. The HYD INTLK indicator remains lit until 26 volts is returned through J13. The counter END COUNT contacts turn Q1 off, deactivating K2, once end of count is reached if the COUNTER INTLK switch is in the STOP/HYD OFF position. Although HYD OFF and EMERGENCY STOP both turn K2 off, EMERGENCY STOP (S4B) provides the added safety of directly shutting down the hydraulic power supply through J19 L and M.

Transistors Q15 and Q10 and relay K4 receive feedback signals from the hydraulic power supply. If an overtemperature or low fluid level condition exists in the hydraulic power supply, the K4 relay will activate the HYD INTLK indicator, open K2 and inhibit the hydraulic power supply start signal. HYD INTLK cannot override an overtemperature or a low fluid level condition. The 24 Vdc feedback received at J19-B is used to keep Q15 in an "on" state. Q10 in series with Q15 is held in an "on" state by the 24 Vdc from J19-H. Initially, with the LOW push button held depressed, K2 cannot be activated until 24 Vdc is received through the starter control (and in some cases, a pressure interlock) at the hydraulic power supply pump.

High pressure (K1) may be activated once K2 has been activated. Contacts across the HIGH push button (S2) latch the K1 relay. A normally closed contact of the LOW push button deactivates HIGH (K1) when LOW is depressed.

5.1.2 PROGRAM RUN/STOP LOGIC

When a system interlock is detected by J14, flip flop A2 is driven to a high (STOP) state. This same condition will exist when the STOP button is used to halt unit operation. The RUN pushbutton, when pressed, energizes contact K3 and resets A2 to a low (RUN) condition. Flip Flop A2 will not reset (go from low to high) until an interlock condition is encountered or the STOP button is activated. To guard against switch noise (electronic bounce) a filter circuit is placed between the STOP button S5 and PIN9 of NOR gate A1.

Clock signals can also alter the state of flip flop A2. When hydraulics are turned off contact K2 opens and A2 is pulsed to a high (STOP) state. The END count signal is sensed at pins 12 and 13 of A1. Output from A1 then drives A2 high and halts the program.

5.1.3 INITIAL STOP LOGIC

During the power on sequence the RUN/STOP flip flop (A2) must be held in the stop state until power is stabilized. The slow RC time constant of the voltage at the input (pins 5 and 6) of A1 assures a 300 to 400 msec "1" pulse at the output (pin 4) during power up. A "1" at pin 6 holds the A2 flip flop in the STOP condition until power is stabilized.

5.1.4 COUNTER INPUT FILTER/BUFFER

The input filter/buffer is, in effect, a Schmitt trigger with an optional feedback capacitor (C22) that limits the maximum switching frequency. The circuit has a transfer characteristic with hysteresis (Fig. 5-1).

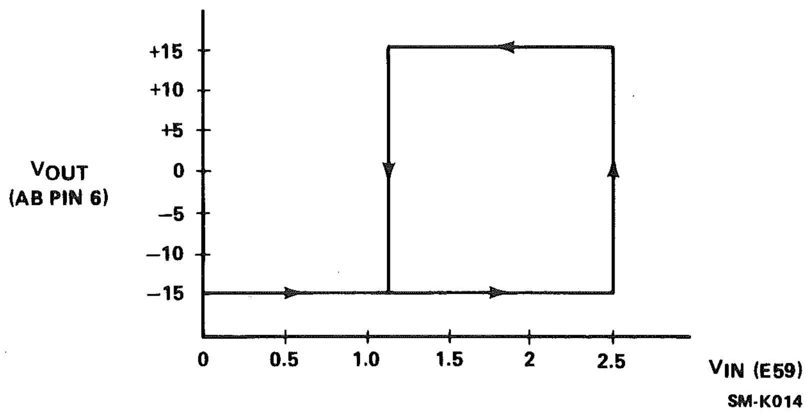

Figure 5-1. Input Filter/Buffer - DC Transfer Characteristic

The hysteresis insures only one output transition for a slowly rising waveform. R48 and CR22 on the output of A8 rectify the count signal. The filter/buffer is followed by a divide-by-10 circuit (A7). Another divide-by-10 is available as an option (A6). These circuits function as digital dividers; one pulse out for every 10 pulses in.

5.1.5 COUNTER DRIVER

The count signal is ac coupled via C20 into a monostable multivibrator. The multivibrator functions as a pulse generator providing an output pulse 20 msec. in duration initiated on the positive transition of the input voltage (see figure 5-2).

Diode CR18 transmits only the positive transition of the count signal at TP4. Q8 then turns on and Q7 turns off (point A, Figure 5-2). As long as Q7 remains off Q8 will remain on. The capacitor charge waveform at the anode of CR17 determines the length of time Q7 will be kept off (normally 20-25 msec.). As soon as Q7 turns on Q8 will turn off (point B, figure 2-5). C17 will begin recharging, and if triggered during this recovery time will not keep Q7 off for the full 20-25 msec. Q9 functions as the 26 volt switching element for the counter.

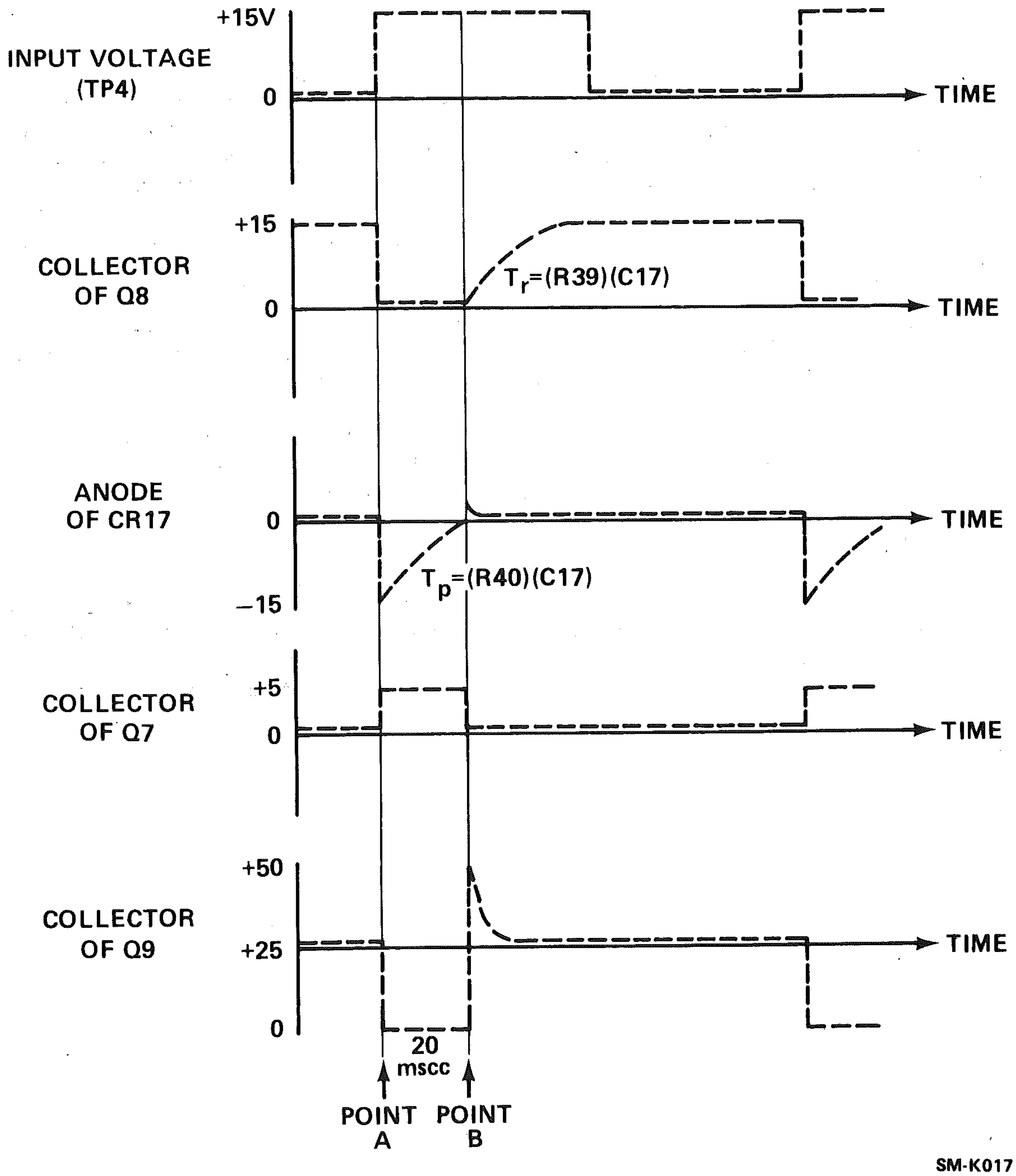

Figure 5-2. Counter Driver - Timing Relationships

5.1.6 AC-DC POWER SUPPLY

To allow a wide range of ac input voltages, the primary windings of the power transformer (see C067587-01) can be connected in series or in parallel. With 105 to 125 Vac across each primary winding the secondary voltages will be within operating range. A system ground is obtained by connecting the green terminal (ac common) to the block terminal (dc common) on the rear panel. The use of separated commons allows custom ground configurations. The 436.11 is equipped with a ±15 Vdc regulated supply, a +12 Vdc C/MOS supply, and a ± 26 Vdc unregulated supply. A +10 Vdc unregulated supply is available for use when a +5 Vdc logic supply is necessary in an option.

The 7815 integrated circuit regulator (A9) supplies the total +15 Vdc load current. This preadjusted regulator includes its own reference. CR32 and CR25 provide reverse bias protection. The output capacitor C29 improves load transient response.

Negative 15 Vdc is derived directly from the +15 Vdc output (see figure 5-3). Amplifier A10 drives the pass element (Q11 and Q12) such that the -15 Vdc output tracks the +15 Vdc output. Current limiting is provided by Q13. Whenever the current through R64 becomes great enough Q13 will turn on, thereby limiting the output of A10. Resistors R62 and R63 constitute the current foldback network.

As a short circuit is encountered the output current decreases (or folds back) from its maximum value. The regulator is high frequency compensated by C34 and C35. CR33 and CR24 provide reverse bias protection. Capacitor C30 improves load transient response. Zeners CR27 and CR28 preregulate the voltage supply for A10. The +12 Vdc C/MOS supply is zener regulated from the +15 Vdc supply.

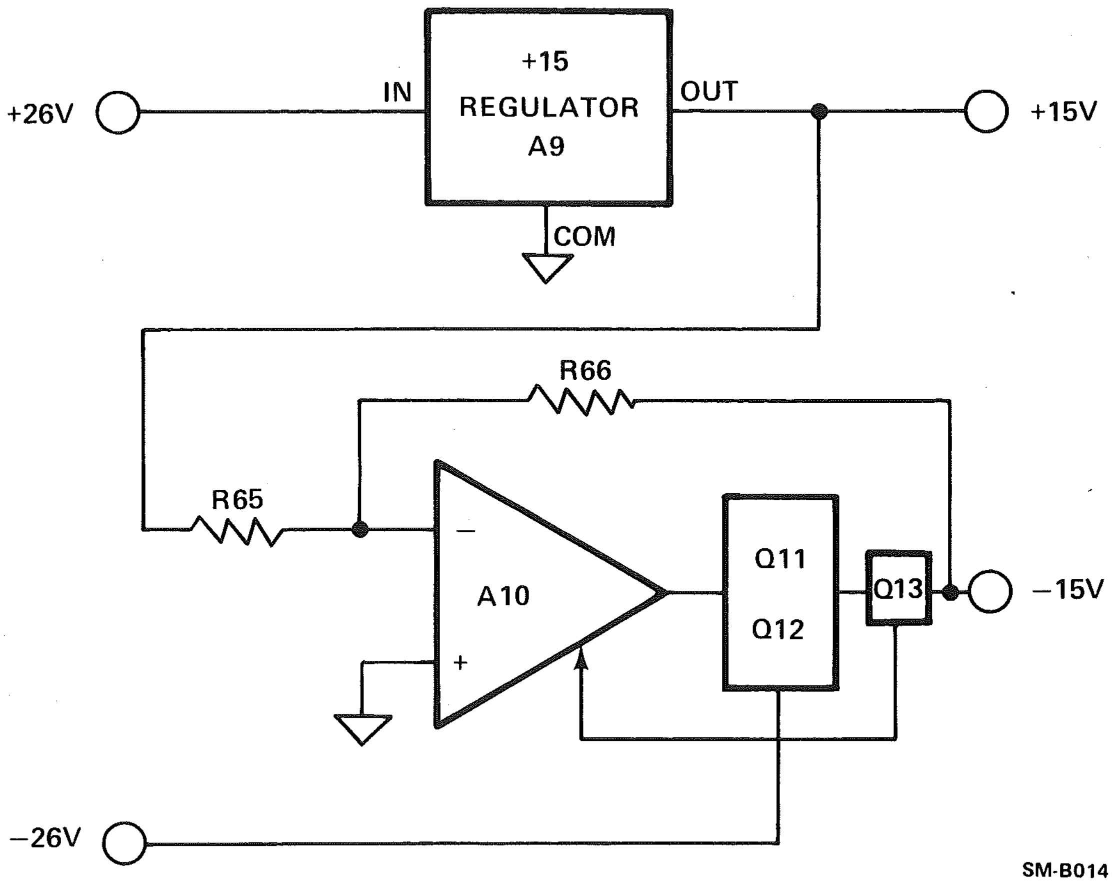

Figure 5-3. ±15 Vdc Regulator - Simplified Schematic

5.2 SOFT RUN/STOP (OPTION A)

Each SOFT RUN/STOP circuit card contains up to four identical channels. Operation of all of the channels is similar to that of channel 1. Reference designations, where mentioned, refer only to channel 1.

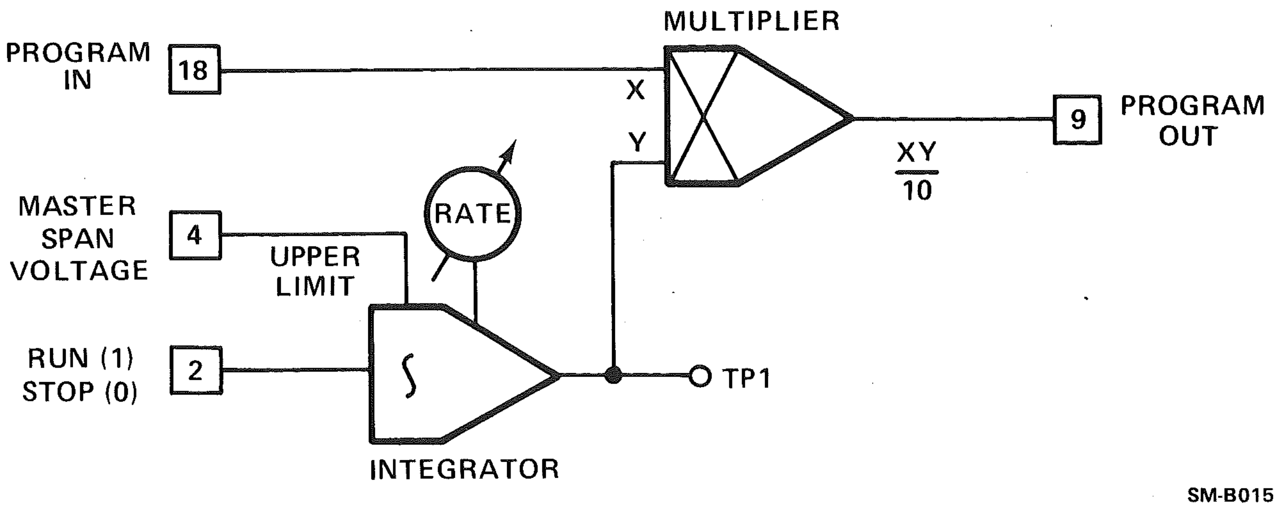

Figure 5-4. Soft RUN/STOP (Option A) - Block Diagram

The multiplier (see figure 5-4) is the combination of an MC1595 Motorola multiplier and AR101 level shift amplifier. The level shift amplifier is necessary because of the high impedance differential output and low gain (0.01) of the MC1595. The program output (pin 9) is the product of the voltage at TP1 and the voltage at PIN 18 divided by 10. Another way of describing the multiplier function is to say the voltage at TP1 acts as an envelope for the AC voltage at pin 18 (see figure 5-5).

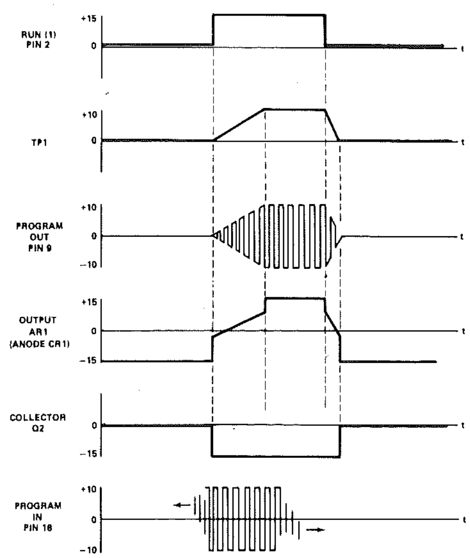

Figure 5-5. Soft RUN/STOP (Option A) - Voltage Waveforms

The integrator (see figure 5-4) corresponds to AR1, Q3 and AR2 on the circuit card (see D068432–01). The limit (saturation) voltages of the integrator are provided by Q3; 0 volts in the stop state and +10 Vdc or the MASTER SPAN voltage in the run state. Field effect transistor Q3 acts as a voltage controlled resistor. The voltage at Q3 gate, as provided by AR1, controls the Q3 source to drain resistance. This resistance changes from a low of less than 100 Ω to a high greater than 100 M Ω (see figure 5–6).

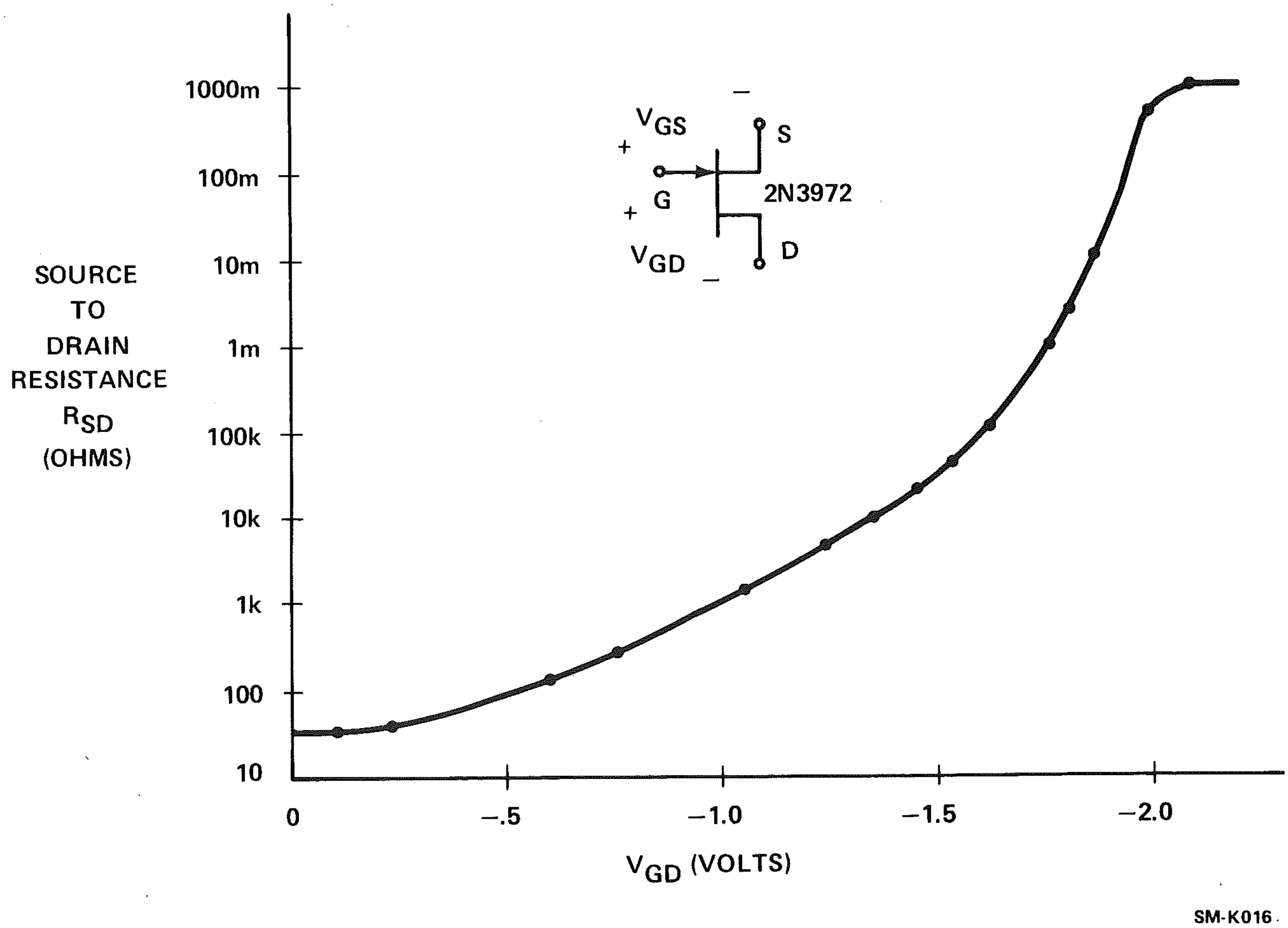

Figure 5-6. Typical Source to Drain Resistance as a Function of Gate to Drain Voltage for 2N3972 as Used in D068423-01.

Q3 and R10 form a variable resistor divider network where the voltage at the Q3/R10 junction is a function of the voltage at the gate of Q3. Voltage follower AR2 acts as a buffer for the Q3/R10 divider. Since AR1 is a differential amplifier the resulting output will be a function of the difference between two input voltages.

One input (pin 3) of AR1 is biased at about 3 volts. A voltage less than 3 volts on the other input will cause positive integration (the integrator inverts). A voltage greater than 3 volts will cause negative integration. Transistor Q1 provides this integrator input; 0 Vdc (RUN) or +15 Vdc (STOP). The integrator RATE is determined by the adjustment of R11 as well as the magnitude of the voltage difference between AR1 pin 3 and the collector of Q1. In the RUN position the RATE is proportional to 3-0 volts divided by R11. In the STOP position the RATE is proportional to 3-15 volts divided by R11. The STOP rate is about 4 times faster than the RUN rate.

The MC1595 is not an ideal multiplier so some portion of the X input will feed through to PROGRAM OUT, even when the Y input is 0 (STOP condition). This characteristic is minimized by the action of Q101. As long as the integrator is at zero volts and AR1 is in negative saturation, Q101 will be turned on, attenuating the X input voltage to the multiplier.

5.3 FUNCTION GENERATOR (OPTION B)

5.3.1 GENERAL

The ±10 volt voltage regulator (see figure 5-7 and D070329-01) provides a stable ±10 volt reference for upper and lower peak detection and the frequency control input to the integrator.

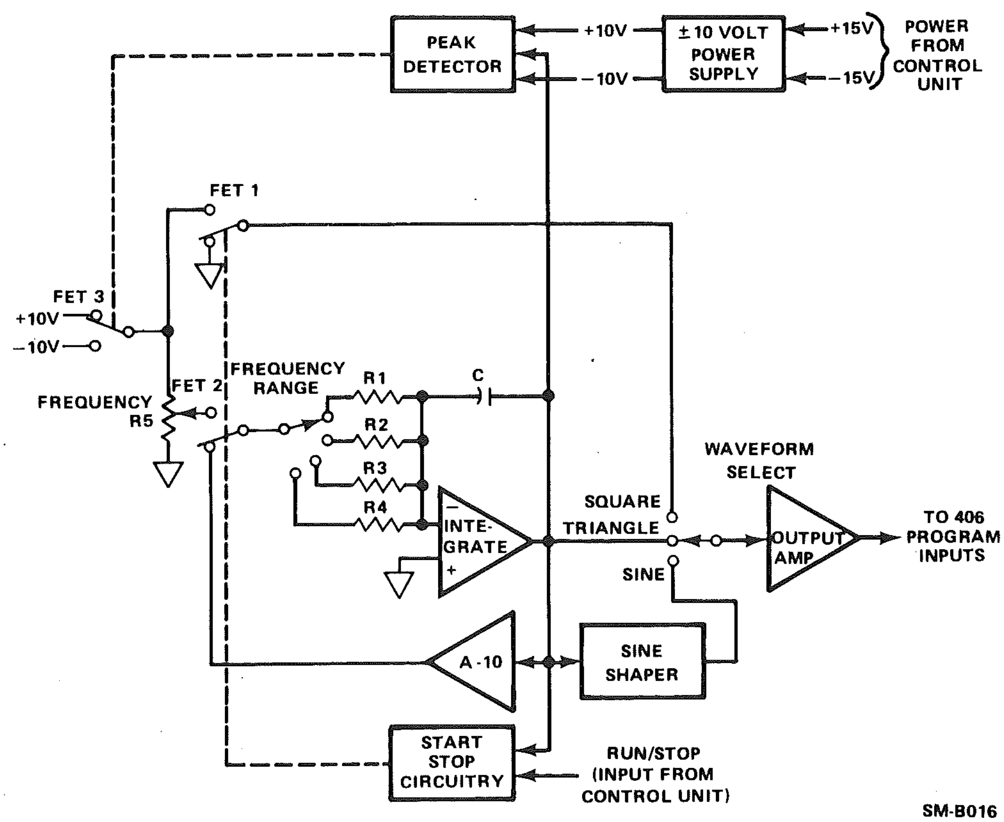

Figure 5-7. Function Generator (Option B) - Block Diagram

The run/stop circuitry controls analog switches FET 1 and FET 2. In the stop condition the output of the integrator is connected back to the input of the integrator via FET 2 and through a gain-of-10 amplifier which creates a closed loop, forcing the output of the integrator to zero volts. When RUN is initiated the analog switches FET 1 and FET 2 change state. The output of the integrator will ramp in either a positive or negative direction depending on the state of analog switch FET 3. When STOP is again initiated the start/stop circuitry will activate analog switches FET 1 and FET 2 at the first zero crossing output of the integrator.

A precision integrator is used to generate a linear triangle waveform. The frequency of the system can be changed by changing the functional rate of the integrator. This is done by changing the input resistors or feedback capacitors. A ten-turn variable voltage divider R5 (input to the integrating input resistors) allows variable frequency control.

The peak detector is used to switch the input polarity to the integrator. When the output of the integrator reaches +10.00 volts (compared to the +10 volt reference) the peak detector switches FET 3 from -10 to +10 volts and the integrator changes direction and ramps toward -10 volts.

The sine shaper utilizes a nonlinear feedback network to shape the triangle into a sinusoidal waveform.

The output amplifier is a noninverting, unity gain, wide band amplifier with the power capability to drive one hundred 406.11 Controllers.

5.3.2 POWER SUPPLY

The ±10 volt reference voltage is derived from the ±15 Vdc outputs of the power supply located on the main circuit board of the 436.11. CR6 is a 6.2 volt, temperature compensated, reference zener diode which provides a stable reference to the noninverting input of op amp AR6. The amount of constant zener current required to maintain the highest temperature stability of the reference zener is obtained from the regulated output through resistor R45. Because the reference voltage equals 6.2 volts, and the desired output is 10.0 volts, the circuit which consists of resistors R44, R43 and R42 provides a gain of 1.61 through the inverting input of the op amp AR6. R44 is a 15-turn potentiometer located on the PC board which is used to adjust the output to +10.00 Vdc. The output of the op amp is short circuit limited at approximately 20ma. The -10 volt reference is derived by inverting the output of the +10 volt supply through inverting op amp AR7.

5.3.3 START/STOP CIRCUITRY

Run or stop is determined primarily by the status of flip-flop A1/1. Energizing the PROGRAM RUN switch on the control unit will cause the voltage at J24 pin 2 to increase from 0 Vdc to +15 Vdc which will set A1/1. Setting flip-flop A1/1 will turn transistor Q7 on and Q9 off. Q7 and Q9 are used as level shifters, with sufficient voltage to turn junction field effect transistor Q8 on and field effect transistors Q6 and Q5 off. The junction field effect transistors serve as analog switches. Turning on Q8 provides an input voltage to integrator AR4 causing the output to ramp in either a positive or negative direction depending upon the polarity of the input voltage. To stop the function generator it is necessary to reset flip-flop A1/1. Resetting A1/1 is initiated by first energizing STOP on the control unit (or when a system interlock is detected) and satisfying zero crossing circuitry AR9, Q12, Q11, and NOR logic gate A2. The zero crossing circuitry is activated each time the output of the function generator crosses zero. The circuit acts as a window type comparator which takes advantage of the finite time required for comparator AR9 to transfer from + to - or - to + saturation. Transistor Q12 is biased to turn on between -10 and -5 volts input and transistor Q11 is biased to turn off between +5 and +10 volts which provides sufficient overlap to generate a +15 volt pulse (2 to 4 μsec) for each zero crossing.

After turning on the control unit power, it is desirable to have the function generator in a stopped condition to eliminate the possiblity of unexpected stress to the specimen upon turning the hydraulics on. This is accomplished by clocking A 1/1 with RC network R84 and C19.

The state of flip-flop A1/1 is changed to a "0" state (the data line pin 9 is connected to common) at approximately 0.2 seconds after power is turned on.

5.3.4 INTEGRATOR

Integrator AR4 is used to generate a linear triangle waveform. The frequency of the triangle waveform can be changed by changing the functional rate of the integrator. This is done by switching the input resistors R12-R15 and feedback capacitors C10 or C18 with the FREQUENCY range switch S1. A 20K ten-turn FREQUENCY potentiometer (input to the integrating resistors) allows continuous frequency control. A voltage follower, AR1, is used to prevent potentiometer loading caused by the integrating resistors to provide accurate frequency settings. The UPPER FREQ potentiometer (R82) is necessary because of the 10% tolerance of feedback capacitor C10 and the LOWER FREQ potentiometer (R83) is necessary because of the 5% total resistance tolerance of the FREQUENCY potentiometer. Transistor Q10 is used as an emitter follower connected in series with AR4 to lower the effective output impedance of the integrator to reduce the susceptibility of switching transients being injected. The output of the integrator is given by the following formula:

$$E_0 = \frac{E_{IN}\, t}{RC}$$

The shape of the triangular waveform is determined by the input voltage E_{IN} and the integrator time constant RC. To maintain a symmetrical triangle wave a precision operational amplifier AR4 (having low input currents with maximum bias current of 7.0 ma) is used as the integrator to minimize input voltage resistors. Because the offset voltage of the op amp is not zero (specified at a maximum of 7.5mV) a SYM (symmetry) potentiometer R28, is provided to eliminate this error. Since the maximum symmetry error occurs at the lowest input voltage, E_{IN}, the adjustment should be made when the FREQUENCY potentiometer is adjusted fully counter-clockwise. In the stop condition the output of the integrator is connected back to the input of the integrator through analog field effect transistor Q6 and through a gain-of-10 amplifier AR5 creating a closed loop, thereby forcing the output of the integrator to zero volts.

NONRUN potentiometer R34 is adjusted for zero volts at the output during a stop condition.

5.3.5 PEAK DETECTOR

The peak detector circuitry is necessary to switch the input polarity to the integrator. The input voltage to the integrator is determined primarily by the status of COS/MOS D type flip-flop A1/2. Assume that the flip-flop is at a "1" level (Q = +15 Vdc pin 1 and $\bar{Q}$ = 0 volts pin 2). The outputs of the flip-flop (Q and $\bar{Q}$) will turn transistor Q4 on and transistor Q2 off. Q2 and Q4 are used as level shifters with sufficient voltage to turn junction field effect transistor Q1 on, and field effect transistor Q3 off. The integrator input voltage E_{IN} through Q1 will be a positive voltage causing the integrator to ramp in a negative direction. When the output of the integrator reaches -10 volts (equal to the -10 volt reference) the output of comparator AR3 goes from 0 volts to +15 volts, resetting flip-flop A1/2 to a "0" level (Q = 0 volts, $\bar{Q}$ = +15 Vdc). The integrator input voltage E_{IN} then changes polarity from +10 to -10 volts through Q3. Comparator AR2 is used to detect the positive peak (+10Vdc) and the process is repeated until the function generator is stopped. The output of the function generator can be started in a positive direction (tension) or a negative direction (compression) by establishing the initial condition of flip-flop A1/2. This is determined by the position of WAVEFORM switch S2A (data input pin 5). The flip-flop is clocked (pin 3) by starting the program RUN (voltage at J24-2 goes from 0 volts to +15 volts).

5.3.6 SINE SHAPER

The sine shaper contains a series of reverse biased diodes (CR19-CR28) used in the feedback network on AR10. The sine wave is produced by a series of linear segment approximations to the triangular wave input. These give 6 linear segment approximations (5 break points) symmetrical for both positive and negative input voltage. Table 5-1 shows the break points and respective closed loop gains.

Table 5-1. Diode Break Points

BREAK POINT DIODES	V_{IN} RANGE TRIANGLE (V)	V_{OUT} RANGE SINE (V)	CLOSED LOOP GAIN
0.4009 (rad) CR19 CR24	0-2.54	0-3.98	1.57
0.6876 (rad) CR20 CR25	2.54-4.37	3.98-6.46	1.35
0.9302 (rad) CR21 CR26	4.37-5.92	6.46-8.17	1.10
1.1523 (rad) CR22 CR27	5.92-7.33	8.17-9.32	0.816
1.3639 (rad) CR23 CR28	7.32-8.7	9.32-9.98	0.48
1.5708 (rad)	8.7-10.0	9.98-10.2	0.169

Diodes CR7 through CR18 provide a first order approximation to cancel the drift of diodes CR19 through CR28, which reduces the drift due to temperature changes. SINE ZERO potentiometer R74 provides the adjustment to obtain a symmetrical waveform about zero. Inverting amplifier AR11 provides the correct gain for a 20 volt peak-to-peak (±10 volt) sine wave output.

5.3.7 OUTPUT AMPLIFIER

The OUTPUT amplifier AR8 is a noninverting, unity gain amplifier capable of driving a 1kΩ load. Because the input impedance of the 406 program isolation amplifier is 100kΩ, the output amplifier AR8 is capable of driving one hundred 406 controllers. The output is short circuit protected at approximately 20 ma. The input waveforms for AR8 are selected by WAVEFORM switch S2B. Switch S2 is a "make-before-break" type switch, so that the input to op amp AR8 is never opened while switching inputs, thereby preventing output transients to the specimen.

5.4 RAMP GENERATOR (OPTION C)

5.4.1 GENERAL

A variable frequency, determined by the RAMP RATE setting (see figure 5-8) is generated by a voltage controlled oscillator (VCO) and applied to decade counters. The RAMP RATE and

RETURN RANGE SELECT switch settings determine the number of times that the VCO frequency will be divided by the decade counters before it is applied to the binary up/down counters. The binary counters provide a digital input to a 16-bit digital-to-analog (D/A) converter. The D/A converter generates an analog ramp output.

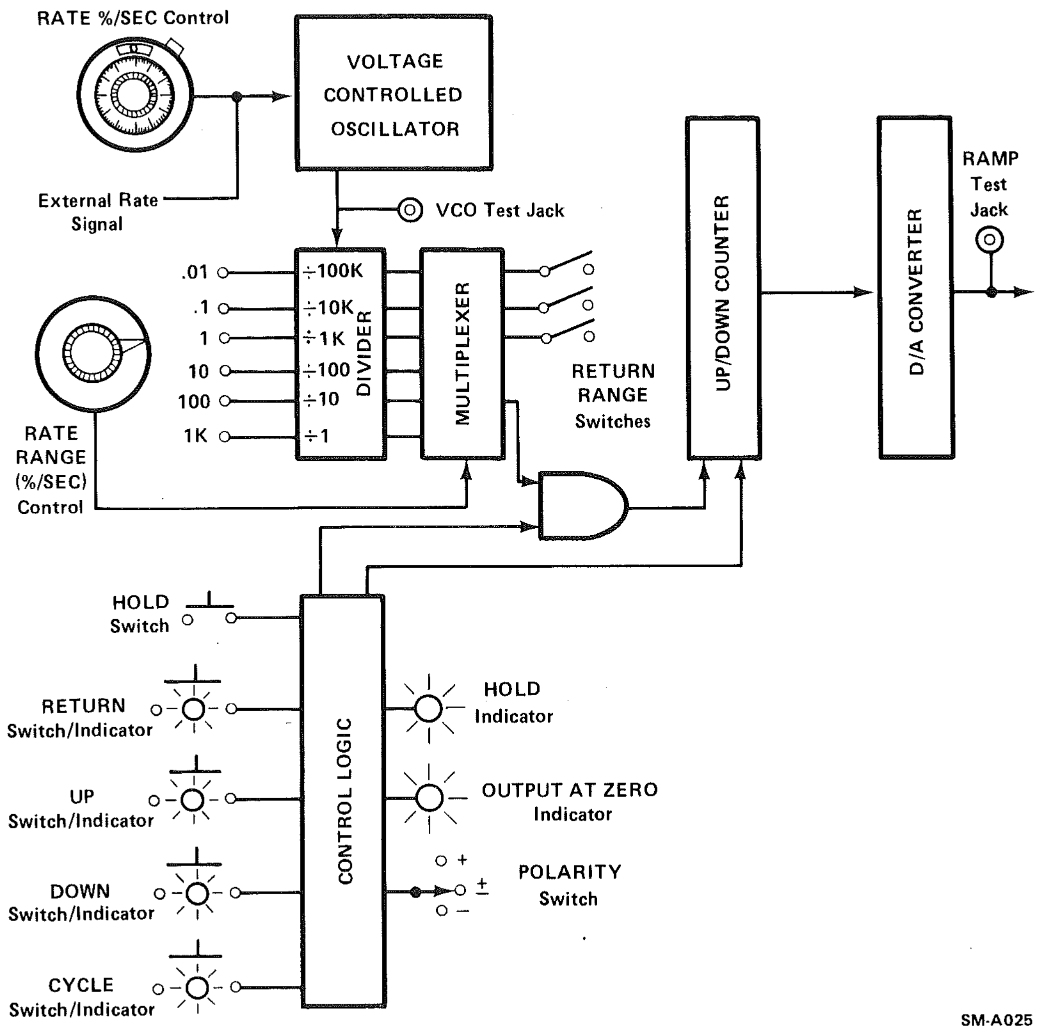

Figure 5-8. Ramp Generator and Remote Test Control (Option C) - Block Diagram

The sheet numbers in the following text refer to sheets 1, 2, and 3 of schematic D312666–01.

5.4.2 POWER UP

When power is applied to the system, a momentary low (logic 0) is created by the charge time of capacitor C7 (sheet 1). The purpose of this initial low is to load the up/down counters (U17 through U20) on the RAMP GENERATOR OUTPUT circuit card (sheet 2) with all ones, except for bit 2^{15}, and to activate SET STOP (J2-10), which prevents the clock from running.

5.4.3 VCO

The voltage controlled oscillator (VCO) (see figure 5-9, and schematic D312666-01) consists primarily of operational buffer amplifiers AR1 through AR3 (sheet 1), resistors R12 and R13, a dual "D"-type flip-flop (U1) and a quad bilateral switch (U2).

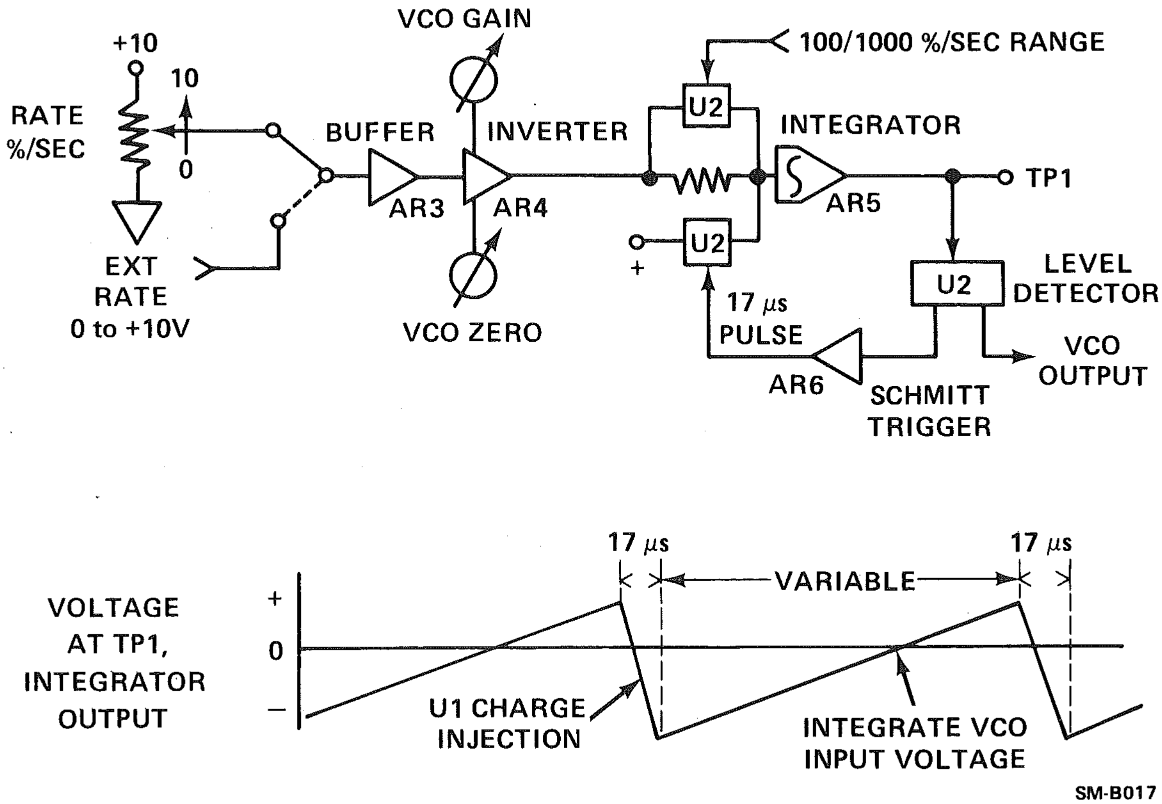

Figure 5-9. VCO - Simplified Schematic

The 0 to +10 Vdc input to the VCO is supplied by the RAMP RATE control on the module front panel, or it may be obtained from an external source connected to pin 4 (sheet 1) of the circuit card. Use of an external VCO input requires moving the jumper wire from E4-E5 to E5-E6.

The VCO functions as an adjustable or programmable clock which controls the ramp rate. Buffer AR1 provides a high input impedance to eliminate circuit loading by the RAMP RATE potentiometer. Inverter AR2 scales the input voltage and compensates for integrator offsets. The 0 to -10 Vdc signal from AR2 is applied to bilateral switch U2 and integrator AR3. When switch U2 (pins 6, 8, 9) is turned on, the oscillator frequency is increased for rate ranges 100 and 1000% /sec. Comparator AR4 and flip-flop U1 act as a precision one shot (monostable multivibrator) with an approximate period of 17 microseconds.

At time t_1 (see figure 5-10) the integrator output has reached the threshold of U1 which results

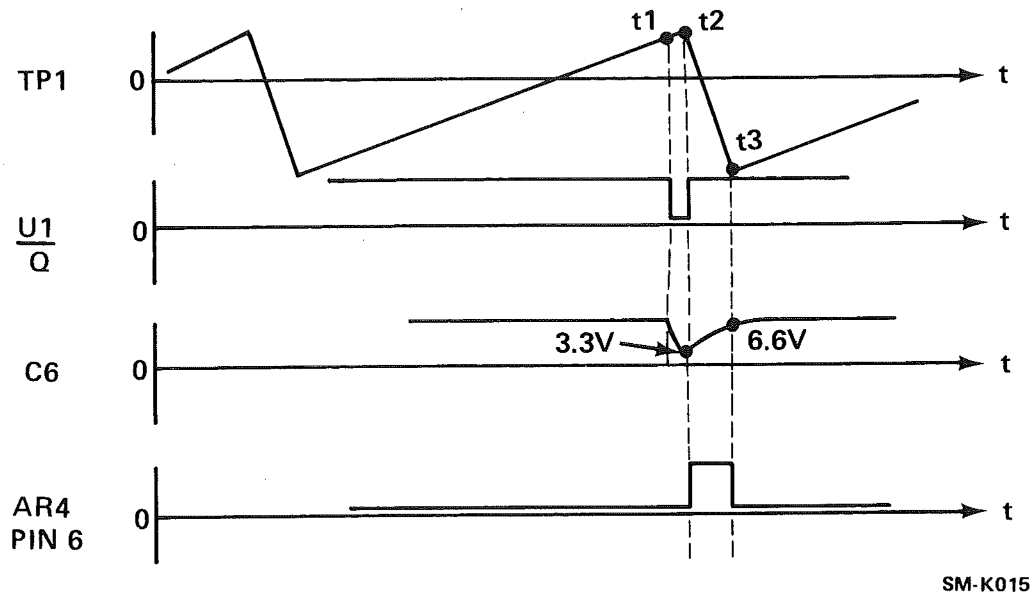

Figure 5-10. VCO - Timing Diagram

in $\overline{Q}$ (pin 12) being set to a low (0 volts). The voltage at C6 then drops according to the R20, C6 time constant until the lower threshold of comparator AR4 has reached +3.3 volts, at time t^2. The output of AR4 goes high (10 volts) turning on switch U2 and resetting U1 $\overline{Q}$. U1 $\overline{Q}$ will remain high until the integrator voltage decreases below the set threshold detected at t_1. AR4 remains high and U2 on until the C6 voltage reaches the upper comparator threshold, 6.6 volts, at t_3. Since the pulse duration of AR4 is dependant only on the lower to upper threshold transition, it will be independant of VCO frequency and will provide a constant charge injection per cycle to the integrator.

5.4.4 CLOCK DIVIDERS AND MULTIPLEXER

The VCO output is routed through a counter divider network for rate range determination. The dual D flip-flop U8 is connected as a divide-by-four, and dual decade counters U6 and U7 divide-by-ten (see table 5-2).

Table 5-2. Clock Frequency for Each Range

RANGE	VCO FREQ	DIVIDER	CLOCK FREQ	D/A RESOLUTION
.01	13,107	4000	3.2767	16 bits
.1	13,107	400	32.767	16 bits
1	13,107	40	327.67	16 bits
10	13,107	4	3276.7	16 bits
100	20,480	10	2.048K	12 bits
1000	20,480	1	20.48K	12 bits

The clock frequencies are not all related by factors of ten since the D/A converter resolution changes from 16 bits to 12 bits for the 100 and 1000%/sec ranges. Analog switch U2 also changes the oscillator frequency from 13.107 kHz to 20.48 kHz as described previously.

Multiplexer U9 selects the appropriate frequency (which is used as the D/A counter clock) under control of the RATE RANGE switch on the remote test control unit and multiplexer U5. During return-to-zero, multiplexer U5 selects the rate range programmed by the RETURN RANGE SELECT switch S1.

5.4.5 RAMP OUTPUT (D/A CONVERTERS AND COUNTERS)

The analog ramp voltage is generated by a digital to analog (D/A) converter, U21, (sheet 2) driven by four 4-bit up/down counters, U17-U20. The output voltage increases or decreases linearly as the binary counters count up or down at a rate determined by the clock frequency derived from the rate range dividers.

For rate ranges 1000 and 100%/sec the least significant four bit counter, U20, is disabled resulting in a 12 bit counter/converter. The output voltage steps then increase by 5mV rather than the 0.3mV steps exhibited for 0.01 through 10%/sec ranges. Due to the complementary offset binary coding of the D/A converter, the counters count up for a decreasing output voltage. Therefore, a logic UP command causes the counters to count down and the output voltage to increase. The count output buffers, U12-U14, translate the C/MOS 12 volt logic levels to the TTL 5 volt logic levels required by the D/A converter. The ramp output amplifier, AR1, converts the D/A current output to a voltage output. The C4, R4 compensation network promotes stability of AR1 even while driving a capacitive load (such as a shielded cable).

5.4.6 CONTROL LOGIC

The ramp generator control logic provides interface between the remote test control unit and the counter/converter output described previously. UP, DOWN, HOLD, RETURN, and CYCLE signals are processed by the logic to provide clock gating and up/down commands to the output counters.

SECTION VI
DIAGRAMS AND COMPONENT PARTS LISTS

This section contains the schematic diagrams, circuit card assembly drawings, and component parts lists for the 436.11A and B Control Units, the Option A Soft Run/Stop Program Conditioner, the Option B Function Generator and the Option C Ramp Generator.

The schematic diagrams included in this section are:

- D337088-01 Control Unit 436.11B
- D068432-01 Soft Run/Stop Program Conditioner Option A
- D070329-01 Function Generator Option B
- D312666-01 Ramp Generator Option C

These schematic diagrams illustrate the electrical circuitry for the 436.11 and are described in section V of this manual.

The circuit card assembly drawing included in this section is:

- D334656-01 Control Unit 436.11B

This assembly drawing is included as a convenience for locating specific components on the circuit board.

The component parts list contains the MTS part number, description, and (when available) the vendor part number of the components included in the various assemblies which constitute the 436.11 Control Unit. The components are listed under the assembly title and assembly part number on which they may be found. These assemblies are:

- 335204-01 Control Unit 436.11B
- 067249-01 Panel Assembly - Left Front
- 067369-01 Panel Assembly - Rear
- 334656-01 Circuit Card Assembly
- 068871-01 Option A - Program Conditioner Assembly Soft Run/Stop
- 068434-01 Option A - Circuit Card Assembly - Soft Run/Stop
- 068464-01 Option A - 1-4 Channel Soft Run/Stop Kit
- 070327-01 Option B - Function Generator Assembly
- 070328-01 Option B - Circuit Card Assembly

- 313151-01 Option C - Ramp Generator
- 312671-01 Option C - Ramp Generator Assembly
- 312668-01 Option C - Circuit Card Assembly
- 312242-01 Option C - Circuit Card Assembly - Ramp Generator Output
- 312305-01 Option C - Remote Control Unit Assembly - Hand Held

The character groups in the REF. DESIGNATOR column correspond to the labeling of the components in the corresponding schematic diagrams.

This section is structured to provide a pictorial reference for the subassemblies in the 436.11B Control Unit, schematic diagrams of the circuitry, and a listing of all parts not locally available. Figure 6-1 illustrates the subassemblies in the 436.11B. The part numbers listed in this figure are the subassembly numbers in the following parts list under which part numbers for a specific subassembly may be found.

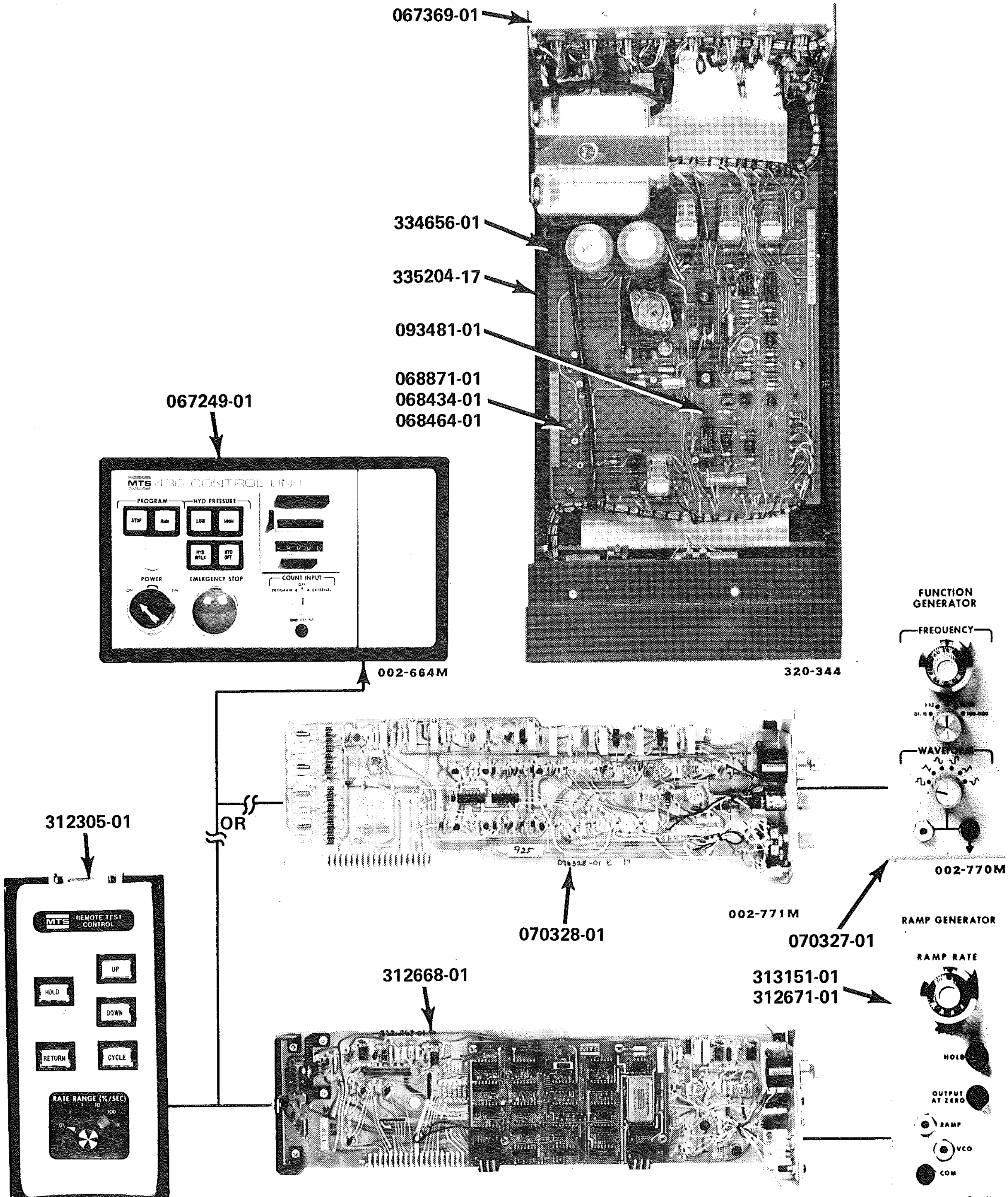

Figure 6-1. 436.11B Subassemblies