THEORY OF OPERATION

OF

MARGINAL CHECKING

FOR

AN/FSQ-7 COMBAT DIRECTION CENTRAL

AND

AN/FSQ-8 COMBAT CONTROL CENTRAL

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PART 1

INTRODUCTION

CHAPTER 1

GENERAL

1.1 PURPOSE AND SCOPE

Part one of this manual provides the background material necessary for a complete understanding of the Marginal Checking System. The overall marginal-checking (MC) operation is discussed. The units involved in marginal checking are described. Terms commonly used in marginal checking are defined. The relationship of this manual to other manuals is discussed, and the methods by which references are made is indicated.

1.2 RELATIONSHIP TO OTHER MANUALS

The information contained in this manual is amplified and complemented by information contained in other manuals. The relationship of the information in this manual to the information in other manuals is discussed in the following paragraphs.

1.2.1 *Basic Circuits for AN/FSQ-7 and AN/FSQ-8, 3-22-0*

Basic Circuits for AN/FSQ-7 and AN/FSQ-8 contains the theory of operation of the basic circuits used in both AN/FSQ-7 and AN/FSQ-8 equipment. Since the Marginal Checking System is composed primarily of relays, circuit breakers (CB's) and other power distribution components, it employs few of these basic circuits. However, an understanding of the operation of the basic circuits is necessary to understand the effect that marginal checking has on these circuits.

1.2.2 *Theory of Operation, Power Supply System for AN/FSQ-7 and AN/FSQ-8, 3-82-0*

The operation of the Marginal Checking System is closely related to the operation and status of the Power Supply System since marginal checking voltages are distributed by the standby power-distribution equipment.

Because of this close relationship, the theory of operation of the Power Supply System must be understood.

1.2.3 *Schematics, Power Supply and Marginal Checking System for AN/FSQ-7 and AN/FSQ-8, 3-262-0*

The schematics for the Power supply and Marginal Checking System must be referred to in order to understand the distribution and control of MC operations. The relationship between components and the division of components into functional groups is shown on the schematics.

1.2.4 *Theory of Programming for AN/FSQ-7 and AN/FSQ-8, 3-112-0*

This manual presents information necessary for understanding the program-controlled operations of the AN/FSQ-7 and -8 equipment. A clear understanding of basic programming and its particular application to marginal checking is essential to understanding computer operation during the calculator mode of marginal checking.

1.3 REFERENCES

Related textual material, tables, and illustrations which appear in this manual, and related material found in other manuals are referred to in the text. The method by which these references are made is discussed below.

1.3.1 Paragraphs

1.3.1.1 Within Same Section or Chapter

References to paragraphs which appear in the same section or chapter as the reference are preceded by the abbreviation par. For example, within Chapter 2, a reference to paragraph 3.2.5.1 of Chapter 2 appears as: (par. 3.2.5.1).

1.3.1.2 In Different Chapter or Part

Reference to paragraphs in chapters or parts other than that in which the reference appears are made as specified above (par. 1.3.1.1) except that the chapter or part is also mentioned. For example, within Chapter 2,

a reference is made to paragraph 4.2.8.1 of Chapter 3. This reference appears as: (par. 4.2.8.1, Ch 3).

If the material referenced is in a different part of the manual, the part is also specified. For example: (par. 4.2.8.1, Part 1, Ch 3).

1.3.2 Illustrations and Figures

Illustration and figure references are similar to paragraph references. The part of the book in which the figure appears is identified by the first number of the reference. For example, (fig. 3–8) refers to the eighth figure in Part 3.

1.3.3 Tables

Tables are referenced in the same manner as figures. For example, reference to the third table in Part 4 appears as: (table 4–3).

1.3.4 Other Manuals

Other manuals are referred to by manual number. The manual referenced may be either a military manual, in which case the manual reference is initiated by the letters "T.O.", or an IBM manual, in which case the manual reference is initiated by a number.

The location of specific subject matter may be found by consulting the index or table of contents of the referenced manual.

1.3.5 Logic Diagrams

A logic-diagram reference is made by placing the logic number within parentheses. For example, reference to logic diagram 5.4.10.1 appears as (5.4.10.1). Note that no abbreviation is used when referring to logic diagrams. Since some of the logic diagrams for the MC System are extensive, a section number is added to facilitate location of components. The section number refers to the vertical divisions indicated in the upper and lower margins of the logic diagrams. A logic diagram reference with a section reference appears as: (5.4.10.1, sect. 3).

1.4 DESCRIPTION OF UNITS

The principle units of the Marginal Checking System are described below. The functional description of each unit is confined to the MC functions of the unit. For complete functional and physical descriptions of the units mentioned, refer to *Theory of Operation, Power Supply System, AN/FSQ-7 and AN/FSQ-8,* 3-82-0. The common names and unit numbers are given in table 1–1. Each of the two duplex units is identical. The letters A and B are used to indicate the computer with which each unit is associated.

1.4.1 Duplex PCD Unit 63

Each duplex PCD unit is divided into four modules, A, B, C, and D, in that order from left to right as viewed from the rear (fig. 1–1).

Module A contains the duplex MC equipment. This equipment includes the reference voltage power supplies, the amplidyne CB's, the amplidyne control chassis, the cam timing units, the MC-voltage CB's and the MC-voltage contactors.

Module B contains relays, power distribution circuitry, and the knife switches which distribute both MC and non-MC voltages to the MCD units.

Module C contains power indicators and controls.

Module D contains the CB's which distribute regulated and unregulated ac to the MCD units, the amplidyne and the convenience outlets. The amplidyne that generates MC excursion voltages is located outside of unit 63.

1.4.2 Simplex PCD Unit 64

There are two simplex PCD units. Each unit is divided into three modules, A, B, and C, in that order from left to right as viewed from the rear (fig. 1–2).

TABLE 1–1. LIST OF NOMENCLATURE

UNIT NO.	COMMON NAME
1	Duplex maintenance console
18	Tape power supply
19	Computer MCD
20	Aux (auxiliary) drum
23	MI (Manual Input)
27	MI and display MCD
29	Drum MCD
31	Output MCD
32	Crosstell
34*	GFI (Gap-filler input)
41*	LRI (Long-range input)
46	Aux drum MCD
47	Simplex Maintenance console
55	Simplex input PD (Power distribution)
56	Simplex CB
58	Simplex MC
59	Simplex common MCD
63	Duplex PCD (Power control and distribution)
64	Simplex PCD

**These units appear only in AN/FSQ-7 equipment*

Module A contains the knife switches for distribution of MC and non-MC voltages to CB units 48 and 56. Module B contains power controls and indicators. Module C contains the CB's which distribute regulated and unregulated ac to the CB units.

1.4.3 MCD Units

There are six pairs of MCD units (units 19, 27, 29, 31, 46, and 59) associated with the duplex equipment. There are no MCD units directly associated with simplex equipment.

Each pair of MCD units is unique in external dimensions and internal divisions. MCD unit 19, a typical MCD unit, is divided into 10 modules, A through K (I is omitted), from left to right as viewed from the front.

All MCD units contain distribution and MC relays, MC CB's and control components and indicators. The MCD units control and distribute power to the load units during normal operation and introduce a variable voltage to the distribution lines during MC operations. The systems with which the MCD units are associated are listed in table 1–2.

TABLE 1–2. SYSTEMS SUPPLIED BY MCD UNITS

MCD UNIT	SYSTEM OR PORTION
19	Central Computer
27	Display Manual Input and Warning Light
29	Main Drum
46	Auxiliary Drum
59	Common equipment input
31	Output

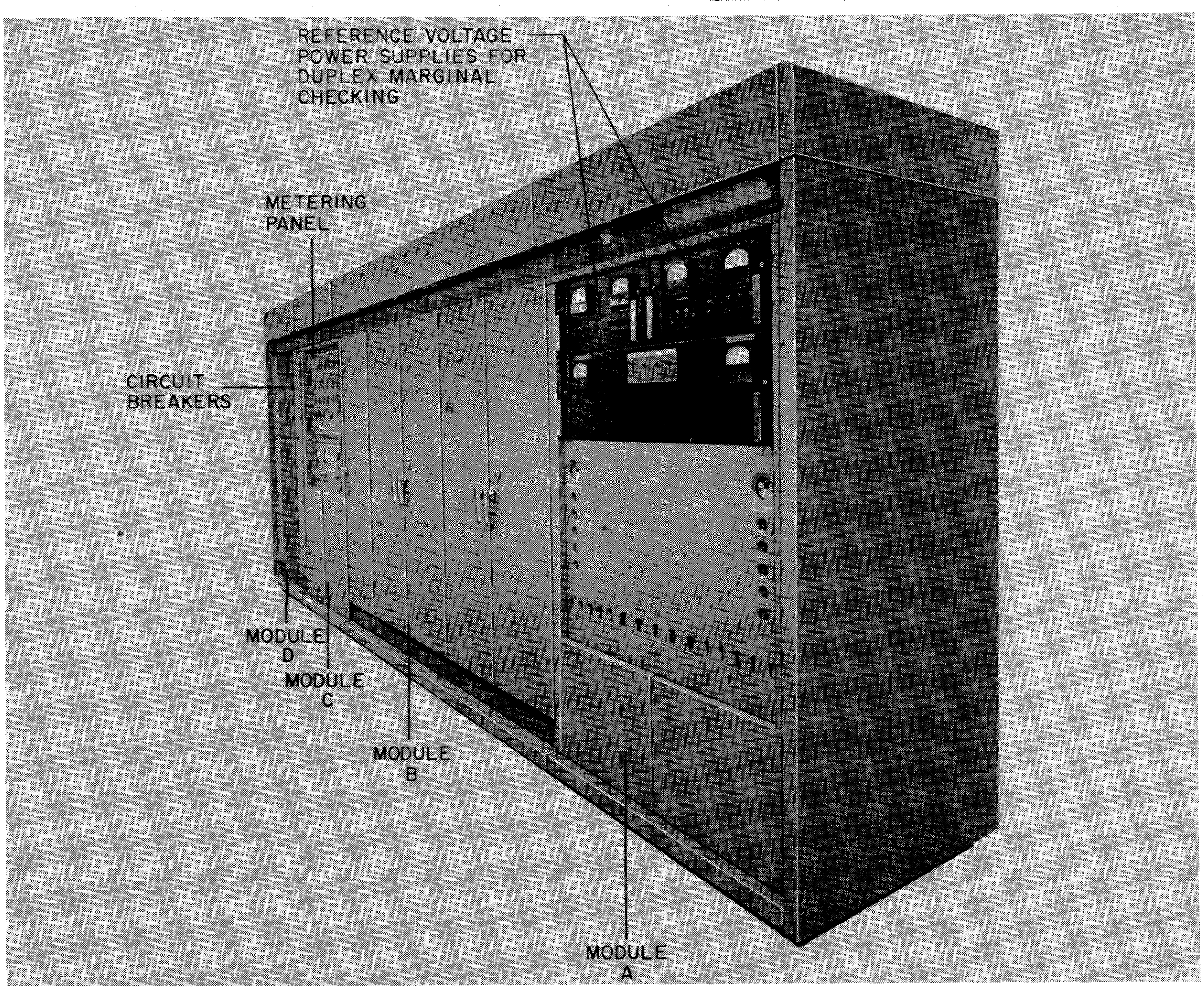


Figure 1–1. PCD Unit 63

1.4.4 Simplex Input PD Unit 55

The simplex input PD unit (fig. 1–3) is composed of 12 modules, A through M, (I is omitted) from right to left as viewed from the wiring side. The unit receives power from either the C or D simplex power system and distributes that power to the simplex input load units.

1.4.5 Simplex Input CB Unit 56

Each simplex input CB unit 56 (fig. 1–4) is composed of six modules, A through F, from right to left as viewed from the wiring side. This unit contains CB's which distribute MC voltages to the input channels. CB's in this unit also distribute unregulated ac to the amplidyne motor and dc to MC unit 58.

1.4.6 Simplex MC Unit 58

The simplex MC unit is composed of four modules, A, B, C, and D from left to right as viewed from the front (fig. 1–5). These modules contain the contactors, relays, and CB's which distribute MC and non-MC voltages to the simplex system (Part 4). The MC relays in this unit perform the same function for the simplex system as the MC relays in the MCD units perform for the duplex system.

1.4.7 Tape Power Supply, Unit 18

Unit 18 provides a separately-controlled MC voltage for the tape drive units. The MC functions of unit 18 are discussed in Part 6.

1.5 COMPONENT IDENTIFICATION

The location and type of the various components used in the Marginal Checking System are designated by a coded combination of numerals and letters. Several coding systems are required since the physical construction of the units varies widely. However, in all coding systems, the numbers which precede the first upper-case

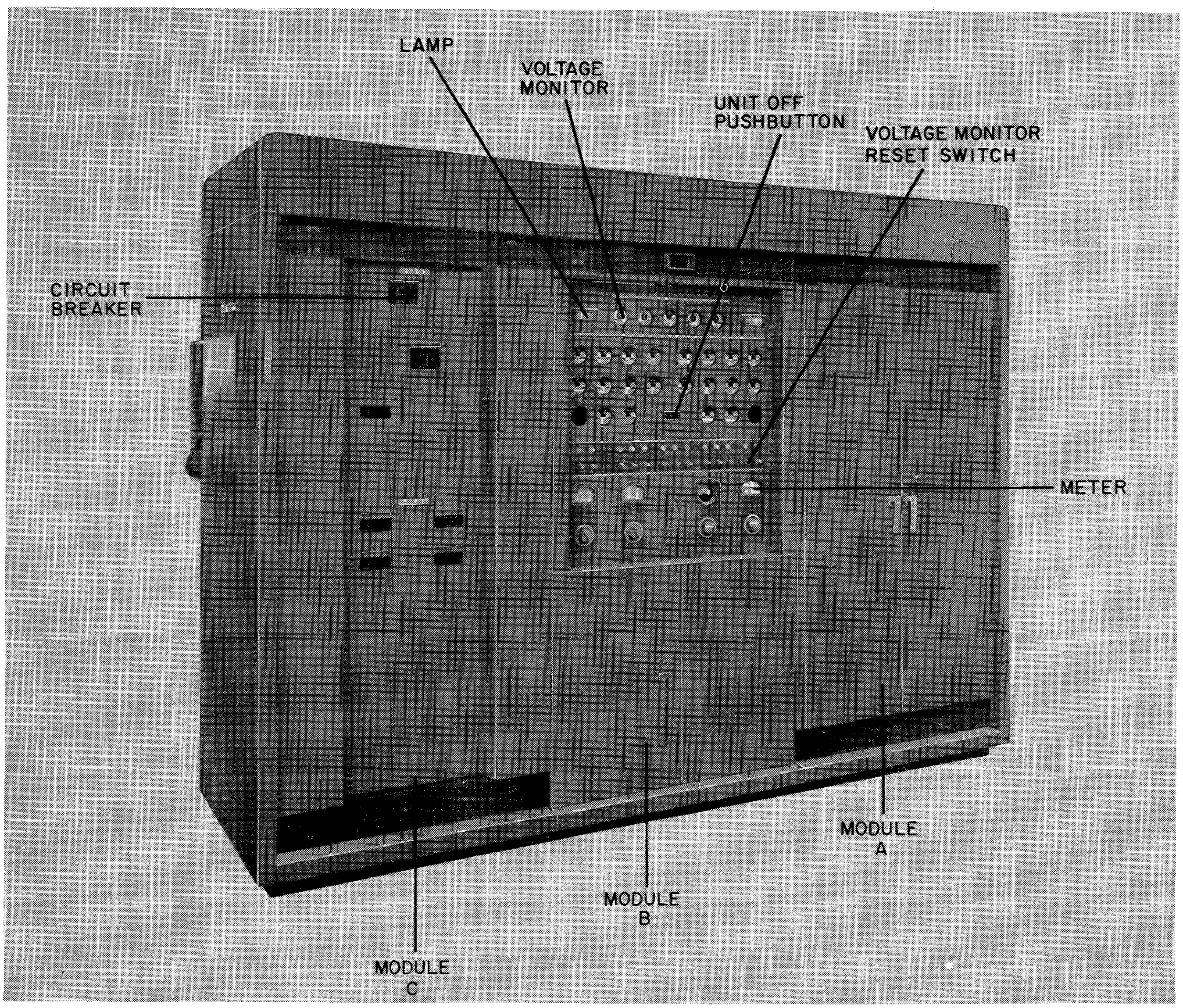


Figure 1–2. PCD Unit 64

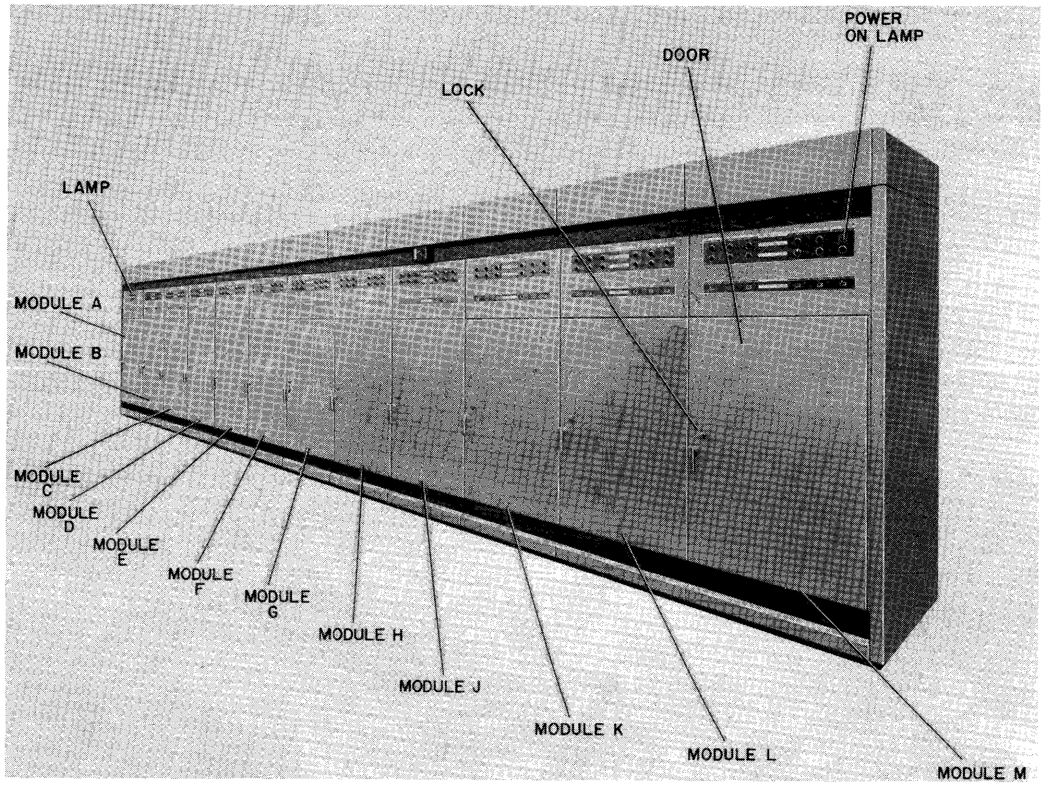


Figure 1–3. Simplex Input PD Unit 55

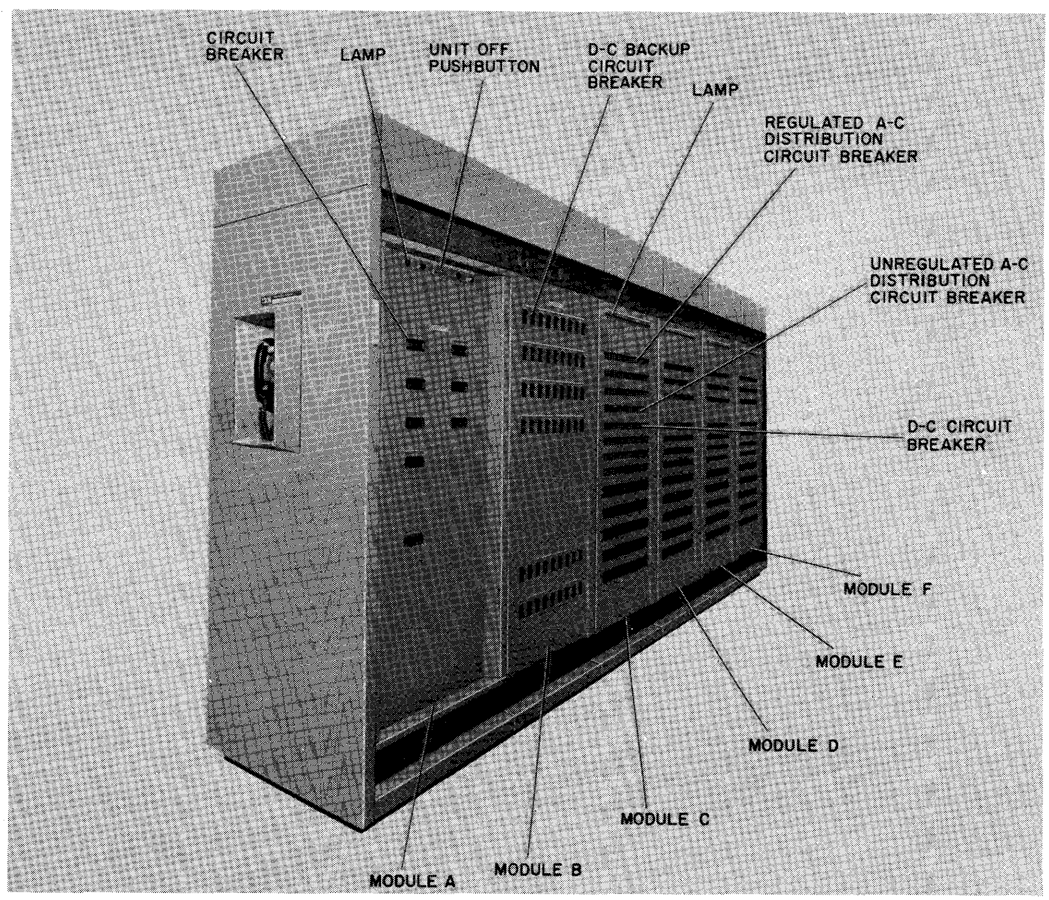


Figure 1–4. Simplex Input CB Unit 56

letter designate the unit in which the component is to be found. The first upper-case letter designates the module or section of the unit. Succeeding numbers and letters indicate the precise physical location and the type of the component. For example, typical location designation 64B7A1f indicates that the component is to be found in unit 64, module B, panel 7, row A, column 1, at terminal f. Component designation 63C5(K31)2a indicates that the component is in unit 63, module C, panel 5; that the component is relay no. 31; and that the specific portion of the relay is contact-set 2, contact a.

Note

To determine the precise location and function of any component, refer to the component layout and component index logic diagrams for the unit in which the component is found.

1.6 USE OF LOGIC DIAGRAMS

Marginal checking information is included on the logic diagrams of the equipment that is marginally checked. Some of this information is included in the block representation of the circuit being checked (fig. 1–6). The OR circuits, AND circuits, and other occasional circuits which are not marginally checked are the only circuit blocks which do not contain MC information.

The MC information appearing on the logic diagram indicates the MC selection for that particular circuit with respect to the parameters of a complete MC selection. The four parameters of a complete duplex MC selection are: equipment group, voltage group, circuit group, and line group. The three parameters of a complete simplex MC selection are: equipment group, voltage group, and circuit group. These terms are defined in paragraph 2.2, Chapter 2.

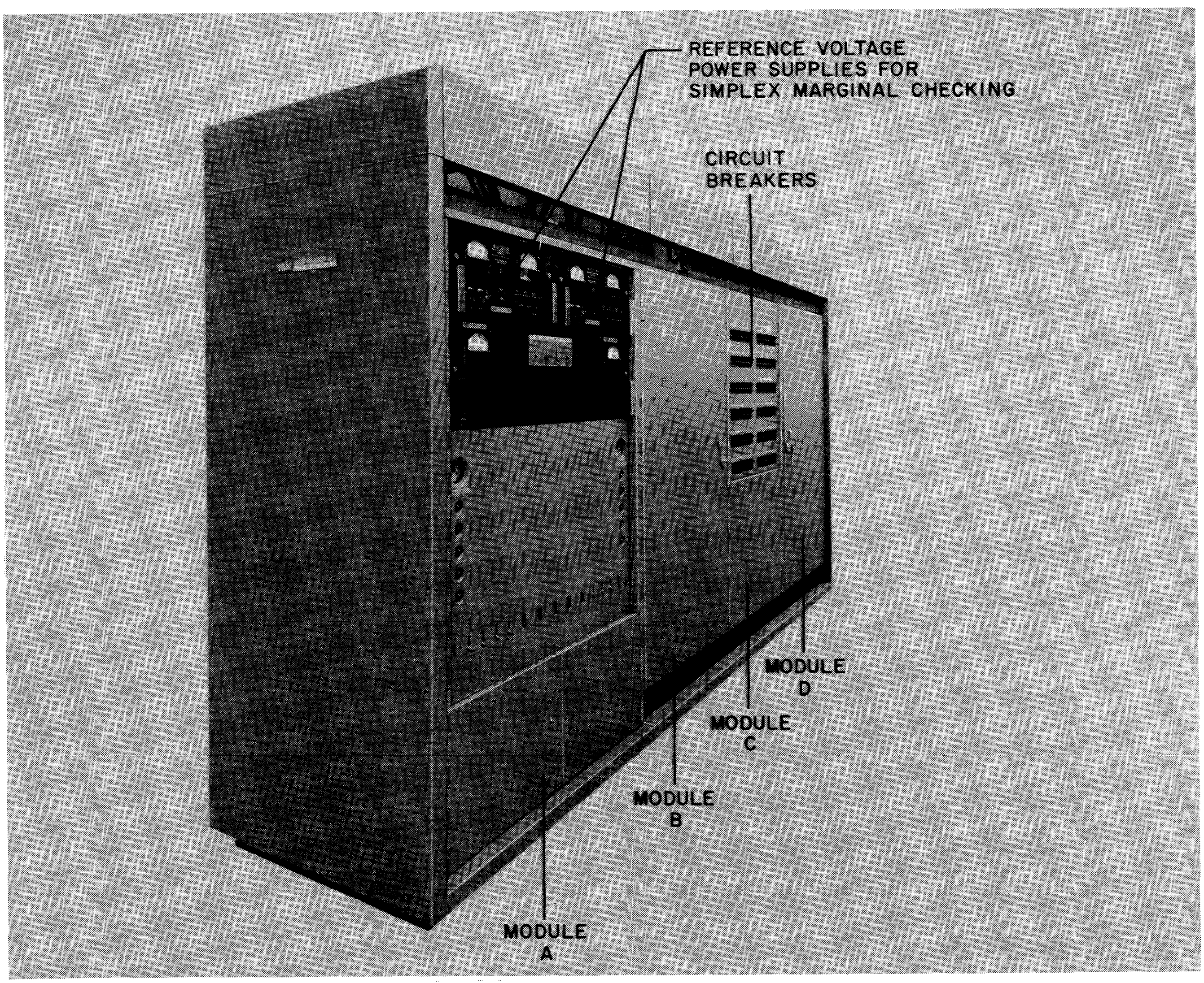


Figure 1–5. Simplex MC Unit 58

The equipment group is indicated beneath the logic number in the upper right-hand corner of the block diagram (fig. 1–6). The equipment group is designated by the letters MC followed by a number (par. 2.2 Ch 2). Asterisks are used to designate more than one equipment group for a logic diagram.

As shown in figure 1–6, the voltage group is indicated by the left-hand numbers inside the circuit block. The voltage and the identifying voltage-group numbers are as follows: (1) +250V, (2) +150V, (3) +90V, (4) −150V, and (5) −300V.

The circuit group is indicated by the letter in the circuit block (fig. 1–6). The circuit groups for duplex equipment are designated by the letters A through F. The circuits groups for simplex equipment are designated by the letters A through M, excluding I.

The line group is indicated by the right-hand number in the circuit block (fig. 1–6). No line group selection is indicated for simplex equipment. The letter S between the voltage-group number and the circuit-group letter indicates simplex equipment.

Circuits which may be tested by more than one selection are represented as shown by the special circuit block in figure 1–6. The selection having the most positive voltage appears inside the block; the most negative voltage appears in the lowest position outside the block. An indirectly checked circuit is represented by the letter M, as shown in the AGT circuit block in figure 1–6.

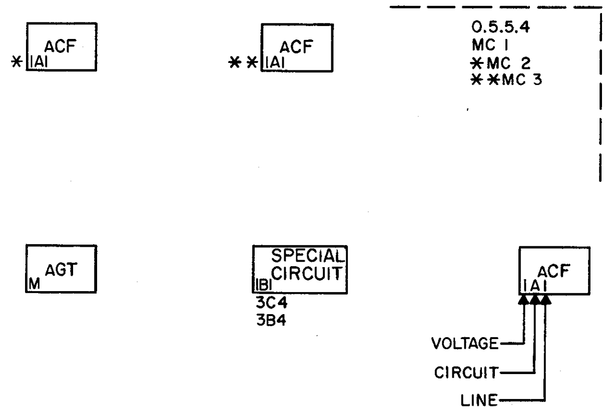


Figure 1–6. MC Selection on Logic Diagrams

CHAPTER 2
MARGINAL CHECKING

2.1 GENERAL

The basic definitions, the philosophy, the purpose, and the methods used in marginal checking are discussed in this chapter. The method of determining circuit reliability is included.

2.2 DEFINITIONS

The following terms are pertinent to the Marginal Checking System:

Amplidyne – An electromechanical amplifier whose output is a variable voltage that is inserted in series with an MC service voltage to produce an MC test voltage (Ch 1, Part 2).

Circuit Group – All those circuits which have approximately the same safe limit for one specific MC voltage.

Equipment Group – The largest amount of equipment which is combined for MC purposes; also called MC group. The nine equipment groups are:

a. MC1 – Memory
b. MC 2 – Arithmetic
c. MC 3 – Program and instruction control
d. MC 4 – IO selection control
e. MC 5 – Drums
f. MC 6 – Displays, manual inputs and warning lights
g. MC 7 – Common phone-line input, duplex portion
h. MC 8 – Outputs
i. MC 9– Simplex equipment

Excursion – The range through which the service voltage is varied during an MC operation; the voltage variation itself.

Line Group – A group of circuits which usually have the same logical functions.

Margin – The amount of voltage variation introduced into a circuit before circuit failure occurs.

MC Service Voltage – One of the five d-c service voltages used for MC purposes.

MC Test Voltage – The algebraic sum of the MC service voltage and the excursion.

Prescribed Margin – The margin at which, if a circuit does not fail, it is assumed to be capable of reliable operation until the next test period.

Safe Limit – An excursion which, if exceeded, could result in damage to circuits and components.

Voltage Group – All of those circuits which are serviced by a particular MC service voltage.

2.3 PHILOSOPHY OF MARGINAL CHECKING

2.3.1 General

Marginal checking is a preventive maintenance procedure used to increase the reliability of AN/FSQ-7 and -8 equipment. A computer containing 5,000 tubes and 10,000 diodes can be expected to fail every half hour after the circuit elements are initially aged. Since the number of diodes and tubes in AN/FSQ-7 and -8 equipment exceeds these quantities, computer failure can be expected more frequently than every half hour. The marginal Checking System is incorporated to increase the useful operating time of the equipment by determining the components which are likely to fail between scheduled maintenance periods. In addition to determining the reliability of the equipment, the Marginal Checking System also aids maintenance personnel in diagnosing and locating troubles.

Marginal checking is usually controlled by a program. The program directs the computer to perform the normal computer operations of addition, subtraction, etc., while the program varies certain circuit parameters about their normal values. In this way, the computer is made to perform normal functions under adverse operating conditions.

2.3.2 Methods of Marginal Checking

Marginal checking is a method of preventive maintenance in which certain operating conditions are varied about their normal values in order to detect components which are deteriorating. These deteriorating components can then be replaced before they fail and cause computer errors. Since components values normally change with age, the variations that can be introduced before component (or circuit) failure occurs becomes less as the components age. The amount of variation from the nominal value that can be introduced before circuit failure occurs is called the margin of reliability of that circuit.

There are three variations which could be introduced into a circuit:

a. Variation of vacuum-tube filament voltages

b. Variation of circuit component values

c. Variation of circuit d-c service voltages

Each of these methods is discussed below.

2.3.2.1 Variation of Filament Voltages

If the filament voltage of a tube were periodically varied, it would be possible to simulate a condition in which a low cathode emission would cause circuit failure. Anticipation of this condition would make it possible to replace the tube before failure occurs.

Low cathode emission could be simulated by periodically decreasing the voltage on the filament from its nominal operating value to a value at which useful emission failed. Each time the filament voltage was decreased the difference between the nominal operating voltage and the failure point would be noted. Over a period of time, this difference, or margin, would become smaller. Eventually, a point would be reached where this difference was so small that emission failure could reasonably be expected before the next periodic check. The tube would be replaced at that time in order to prevent tube failure from occurring during computer operating time. This failure-anticipation and -prevention would improve computer reliability and minimize the computer down-time.

However, this method of marginal checking is not used, except in some display-console tubes, *Maintenance Techniques and Procedures, Display System of AN/FSQ-7 and -8,* 3-182-0 because it is limited to the anticipation and prevention of those computer failures caused only by tube failure. A more comprehensive method is necessary to detect imminent failures caused by failures of components other than vacuum tubes.

2.3.2.2 Variation of Component Values

Failure of components other than vacuum tubes could be anticipated by a periodic artificial aging of the components. Artificial aging could be accomplished by introducing components with different values into the circuit to determine the effects of such a change. By periodically noting the amount of change necessary to cause circuit failure, and by determining how much normal component aging would produce such a change, a time could be established at which the component must be replaced to prevent circuit failure before the next scheduled test.

To introduce changes to component values, it would be necessary to connect variable components to the normal circuit for testing purposes. Because of the large quantity of circuit components used in AN/FSQ-7 and -8 equipment, this method of marginal checking would be impractical. Therefore, it is not used.

2.3.2.3 Variation of D-C Service Voltage

Another method of marginal checking (that used in AN/FSQ-7 and -8 equipment) is to vary the service voltage on the circuit. Since the circuit components change in value with age, the amount that a circuit's service voltage may be varied before circuit failure occurs will also change. The amount of voltage variations that can be introduced before the circuit fails is called the margin of the voltage on the circuit. As the components age, the margin decreases. When the circuit fails at normal operating voltage, the margin is zero. However, if the margin is regularly checked and its gradual decrease is noted, the time of circuit failure can be anticipated. The components which would cause the anticipated failure can then be replaced to prevent the circuit from failing during normal equipment operation.

This method of marginal checking provides a practical test method applicable to all equipment components. For this reason, it is the method of marginal checking used in AN/FSQ-7 and -8 equipment.

2.3.3 Marginal Checking Techniques

The actual circuit to be marginally checked is selected on the basis of an equipment breakdown (Ch 3). The MC procedure must simulate a normal circuit operation so that the MC test may be performed under dynamic circuit conditions.

Figure 1–7 represents a typical circuit selected for marginal checking. The operation of this circuit is such that successive pulses place a 1 in FF 2, transfer it to FF 4, and then clear both flip-flops.

During the MC operation, an excursion is applied to the MC voltage line of FF 2. Assume that at some excursion value, the computer senses that a 1 was not transferred to FF 4. The excursion is stopped and the margin is noted. A first analysis might indicate that FF 2 has deteriorated enough to cause circuit failure when the excursion was applied. A further analysis would indicate that the defect may not be in FF 2. It is possible that gate tube (GT) 1 is delivering a pulse with an amplitude which is so small that a slight change in the voltage applied to FF 2 causes the circuit to fail. It is also possible that GT 3 has aged to the point where the output of FF 2 must be normal in order for GT 3 to pass the pulse.

By using this type of analysis, maintenance personnel can determine the overall operating condition of the various elements of the equipment. By using marginal checking, maintenance personnel can determine whether failures may be expected within a given time, or whether a particular portion of the equipment has

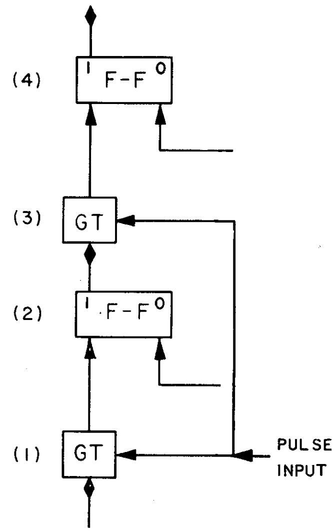


Figure 1–7. Typical MC Selected Circuit

deteriorated to the extent that components must be replaced to prevent system failure.

2.4 DETERMINING CIRCUIT RELIABILITY

When a circuit is designed, an initial prescribed margin, based on line voltage and safe limits, is assigned. During MC tests, the prescribed margin is applied to the circuit. If the circuit functions properly with the prescribed margin applied, the circuit is assumed to be capable of reliable operation until the next scheduled test.

To determine the voltage at which the circuit will fail, increasing excursions are applied until the circuit fails. The results of this test are plotted to establish a life curve (margin at failure versus circuit operating time, fig. 1–8). A new prescribed margin is now established on the premise that the circuit will fail before the next test period if the present margin is equal to or less than a certain value. The circuit being tested must be replaced before the margin reaches its prescribed limit. For example, if a reliability test shows that the margin is 25V, it is apparent from the life curve (fig. 1–8) that the margin will drop below the allowable limit before the next reliability test is performed. At this point, the circuit is replaced to prevent circuit failure during computer operation.

A useful life curve is one that allows the margin limit to be approached gradually during each successive testing period. Certain circuits do not have useful curves because they age gradually but fail suddenly. Other circuits operate for long periods with practically no change in margin, and then the margin drops sharply in a short period of time. Since, in these latter circuits, no appreciable decrease takes place, it is difficult to determine when the circuit should be replaced. The circuits for which life curves cannot be established represent only a small percentage of the circuits in the AN/FSQ-7 and -8 equipment. Most circuits in the equipment have life curves which allow relatively accurate determination of the time at which the circuit must be replaced to prevent failure during computer operating time.

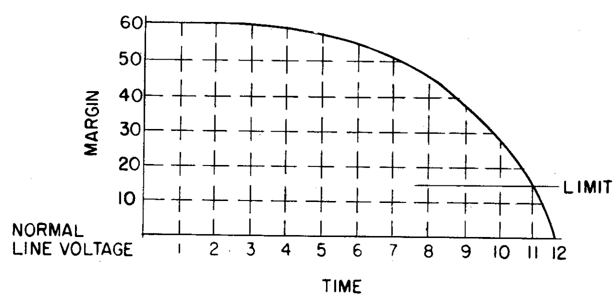


Figure 1–8. Typical Life Curve

CHAPTER 3

SYSTEM BREAKDOWN FOR MARGINAL CHECKING

3.1 GENERAL

Marginal checking is performed only on selected portions of the equipment at one time. The size of the selected portion permits isolation of an equipment fault in a relatively small area. To permit isolation of a fault, the duplex equipment is broken down into MC groups, voltage groups, circuit groups, and line groups; the simplex equipment is broken down into MC voltage, and circuit groups, (fig. 1–9). A further division of simplex equipment is permitted by the simplex UNIT STATUS switches.

3.2 MC EQUIPMENT GROUPS

The MC equipment groups are based on the physical location and function of the equipment. The nine equipment groups are identified in paragraph 2.2.

Only one of the first eight groups may be selected at any one time. These groups are marginally checked by the duplex MC equipment. The ninth group is marginally checked by the simplex MC equipment. This group may be selected and tested simultaneously with one of the eight duplex MC groups.

3.3 VOLTAGE GROUPS

The +250-, +150-, +90-, and —300-volt potentials in both duplex and simplex equipment may be varied for marginal checking. Only one of these voltages may be varied at one time because only one amplidyne (variable voltage source) is available in each MC system. The combination of an equipment group and a single voltage represents the largest amount of equipment that can be tested at one time, and this combination is further broken down into circuit groups and line groups.

3.4 CIRCUIT GROUPS

A voltage group is divided into circuit groups on the basis of circuit type and application. Each voltage group is divided into six circuit groups in duplex equip-

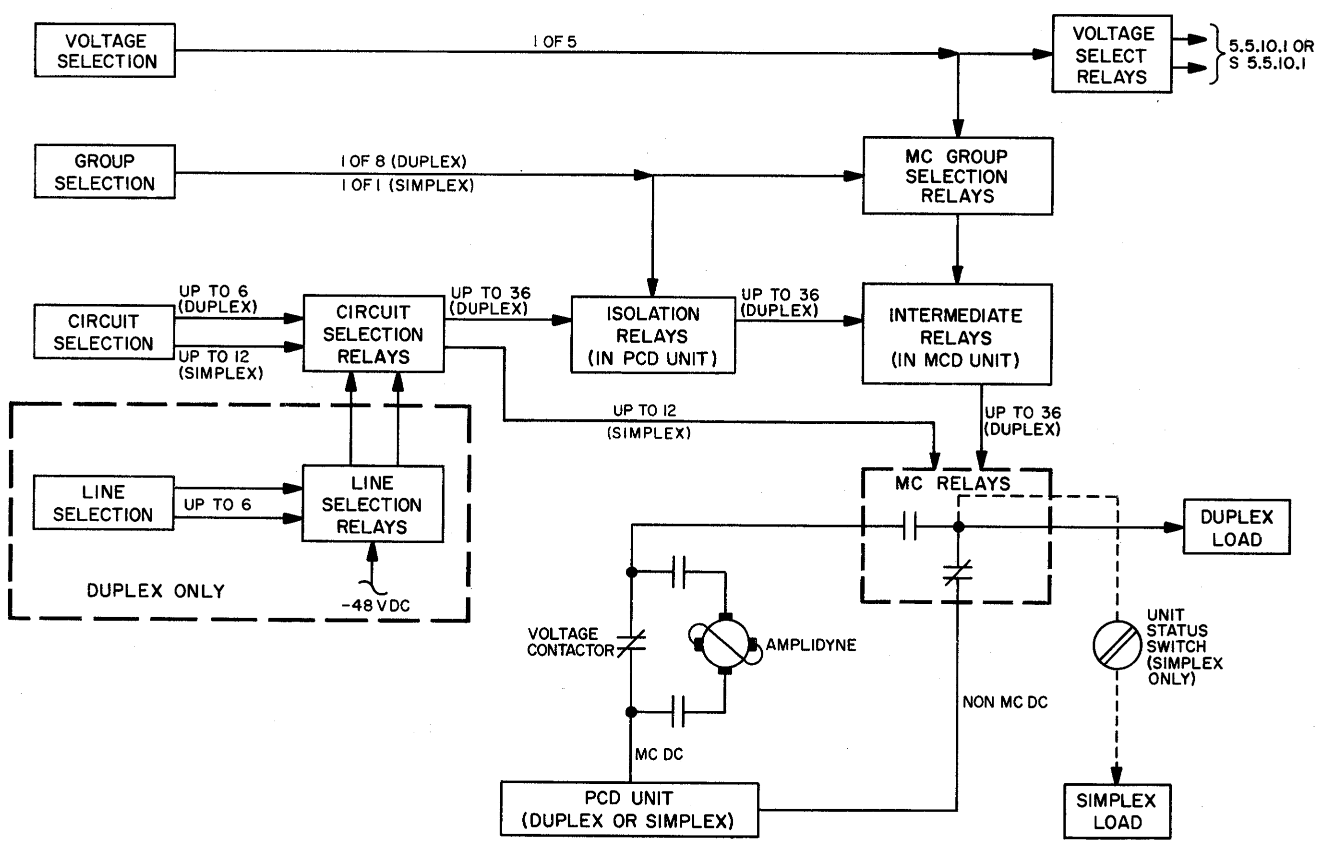


Figure 1–9. Marginal Checking System, Simplified Block Diagram

ment and 12 circuit groups in simplex equipment. Any number of circuit groups may be selected simultaneously.

When a circuit group is selected, only the circuits serviced by the selected MC voltage within the selected MC equipment group will be marginally checked. This selection isolates equipment faults to a relatively small area.

3.5 DUPLEX LINE GROUPS

In duplex equipment, circuit groups are further divided into line groups. This breakdown is made to distinguish various parts of a circuit group. Each circuit group is divided into six line groups, any of which may be selected at one time.

The amount of simplex equipment does not warrant a line-group breakdown. In place of a line-group breakdown, simplex equipment is provided with UNIT STATUS switches.

3.6 SIMPLEX UNIT STATUS SWITCHES

The circuit groups of the simplex equipment may be subdivided by the UNIT STATUS switches on the simplex maintenance console. Only those channels whose UNIT STATUS switches are in the STANDBY-MC position are connected to the simplex MC system. Any number of UNIT STATUS switches may be placed in the STANDBY-MC position simultaneously.

PART 2

BASIC CONSIDERATIONS

CHAPTER 1

INTRODUCTION

This part discusses those aspects of marginal checking which are applicable to both the duplex and the simplex MC system. These common aspects include the theory of operation of the amplidyne, the field-control chassis, and the zero-sense chassis; the modes of control of the MC systems; and the programming aspects of marginal checking.

To differentiate between the components and logic-drawing references of the duplex and the simplex systems, the following scheme is used: The duplex-component designation is mentioned in the text; the simplex component that performs the same function is designated in brackets immediately following the duplex-component designation. For logic-drawing references, the simplex reference is always initiated by an S or by C/D. Where the duplex and simplex systems are dissimilar, each is explained separately. Special note is made of those components, functions, etc., that are unique to one system. If no distinction is made, it may be assumed that the statement is valid for both duplex and simplex MC systems.

CHAPTER 2

AMPLIDYNE, FIELD-CONTROL CHASSIS, AND ZERO-SENSE CHASSIS

2.1 INTRODUCTION

This chapter contains information on the theory of operation of the amplidyne, field-control chassis and zero-sense chassis. These components are discussed here because they operate in the same manner in both duplex and simplex MC systems.

2.2 AMPLIDYNE THEORY

2.2.1 General

The amplidyne is an electromechanical device used to vary an MC voltage. Basically, the amplidyne is an externally-driven, d-c generator that produces a large power gain. The amplification factor, or power gain, of a typical amplidyne is between 10,000 to 1 and 50,000 to 1.

The amplidyne used in each MC system is a 3-kw, 125Vdc generator driven by a 5-hp, 208Vac, 3-phase motor operating at 1,800 rpm. The amplidyne generates a variable d-c voltage which is inserted in series with an MC voltage during MC tests.

The field-control winding of the amplidyne receives a small control current from the amplidyne field-control chassis. The amount and direction of the control current are determined by the excursion selected and the difference between the reference input voltage and amplidyne output (fig. 2–1.)

2.2.2 Amplidyne Generator Operation

The operation of an amplidyne generator can be compared to the operation of a d-c generator. When a d-c control voltage is applied to the field windings of a conventional generator, a small current passes through these windings and causes a magnetic field, (the excitation flux, ϕ_e to be developed. As the armature revolves, a coil of wire wound on the armature cuts the excitation flux, (A, fig. 2–2) and induces a voltage (the output voltage) in the armature winding. This output voltage is taken from the armature by two brushes which make contact with the commutator. When the output voltage is applied to a load, a relatively large current flows through the armature winding. The current flowing through the armature winding also causes a magnetic flux, called the armature reaction flux (ϕ_a) which is at right angles to ϕ_e (A, fig. 2–2).

If the load of the d-c generator described above is replaced by a short circuit (B, fig. 2–2), a greater current will flow in the armature winding, and ϕ_a will be greatly increased. Since the armature winding cuts the excitation flux ϕ_e, a large voltage will be induced in the armature at right angles to ϕ_a. By placing a set of brushes midway between the short-circuited brushes (C, fig. 2–2), sufficient voltage will be obtained to supply current to an external load, and still permit a large short-circuit current to flow between the original brushes. A d-c generator having one set of brushes short circuited and a second set supplying a load voltage is called an amplidyne.

When the second set of brushes supply current to an external load, a second armature reaction flux, ϕ_b, is set up. This reaction flux opposes the excitation flux, ϕ_e, and cancels it. Since the excitation flux caused by the field winding is no longer effective, the current in the field winding is no longer controlling the output of the amplidyne. To prevent ϕ_b from cancelling ϕ_e, an additional winding is placed on the field poles (D, fig. 2–2). This winding, called the interpole winding, is in series with the load. Flux ϕ_c, produced by the current in the interpole winding, exactly cancels ϕ_b(for all load

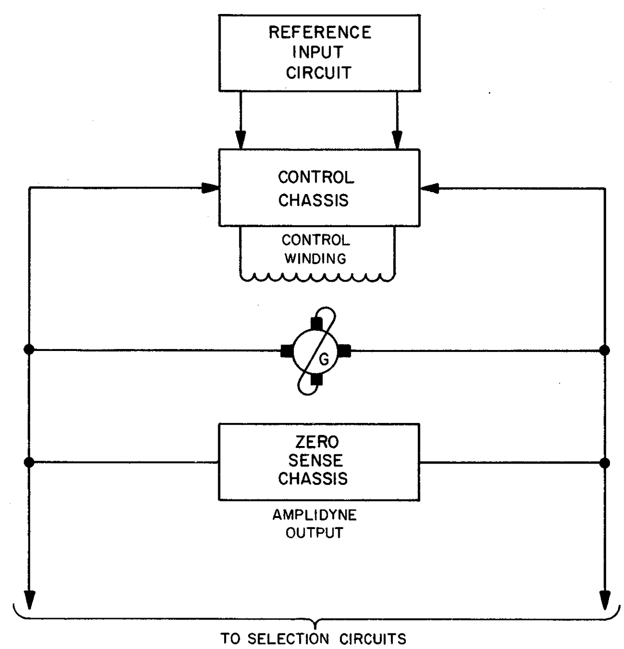


Figure 2–1. Amplidyne, Field-Control Chassis and Zero-Sense Chassis, Block Diagram

currents in the operating range of the amplidyne) and permits the relatively small current in the field winding to control the large output current. For example, the d-c generator first described might require 5 amps in the field winding in order to deliver 100 amps to a load. However, the amplidyne developed from the d-c generator might require a field current of only 50 ma in order to deliver 100 amps to a load.

2.2.3 Amplidyne Generator Control

The amplidyne must be capable of producing either a positive or negative output. The amount and direction of the amplidyne output is determined by the amount and direction of the current in the field winding and the excitation flux produced by it. Placing a center tap on the field winding (D, fig. 2-2) permits this type of control. The field-control chassis (par 2.3) provides a control current which increases the current in one half of the field winding and simultaneously decreases it in the other half. When the control current is increased in one half, the amplidyne output has one polarity. When the control current is increased in the other half, the polarity of the output is reversed. When the amplidyne is running but there is no control signal, the magnetic fluxes produced by each half of the field winding are equal and opposing, and cancel each other. Therefore, ϕ_e is zero, and the amplidyne output is zero.

2.3 FIELD CONTROL CHASSIS

2.3.1 General

The field control chassis controls the output of the amplidyne by supplying the field-control winding with a current of the proper polarity and amplitude to produce the desired output voltage. The control-winding current is determined by the difference between the reference-input voltage and the amplidyne output (fig. 2–1). The field control chassis uses two magnetic amplifiers in buck-boost action to determine the amplitude and direction of the amplidyne field current. The field -control chassis also contains circuits which stabilize the amplidyne, control the overshoot of the amplidyne, and prevent the amplidyne output from reaching a maximum if the reference-input circuits fail.

2.3.2 Magnetic Amplifier

A magnetic amplifier consists of magnetic core with several windings. In the basic magnetic amplifier shown in figure 2–3, the core is saturated by the current in the gate winding. A steady d-c current in the bias

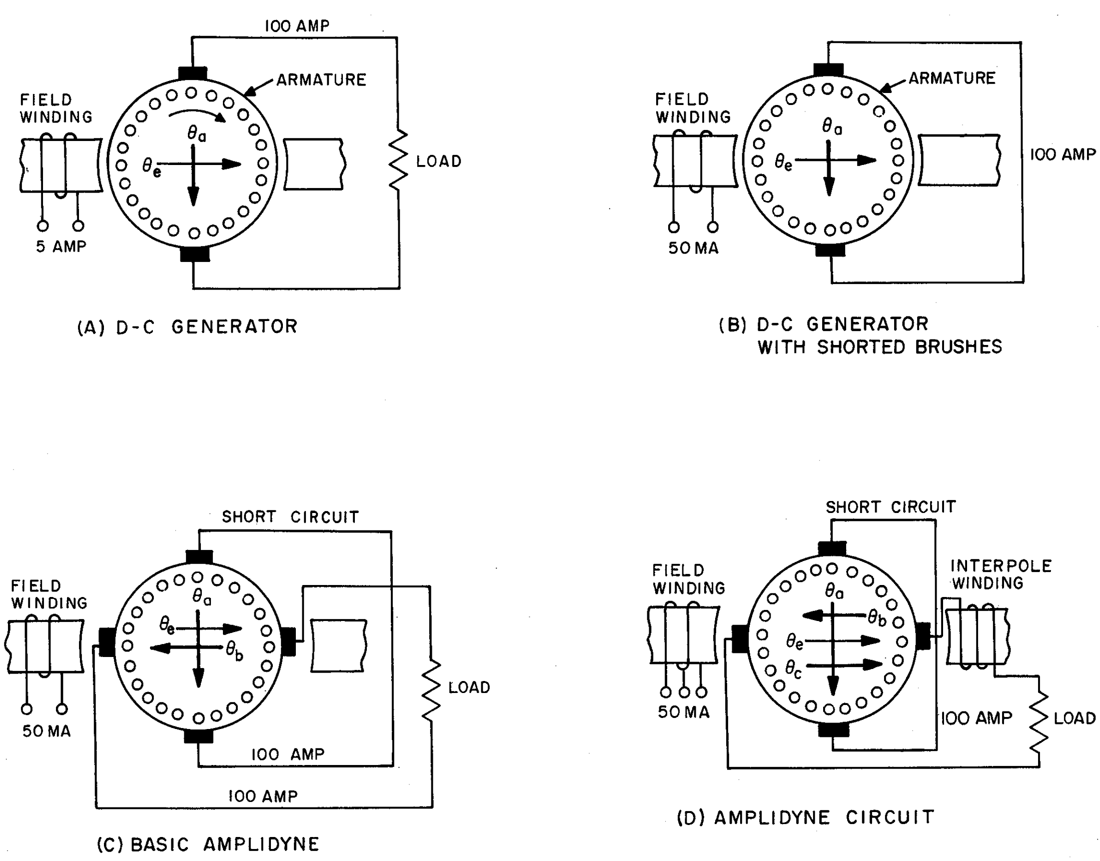


Figure 2—2. Development of the Amplidyne

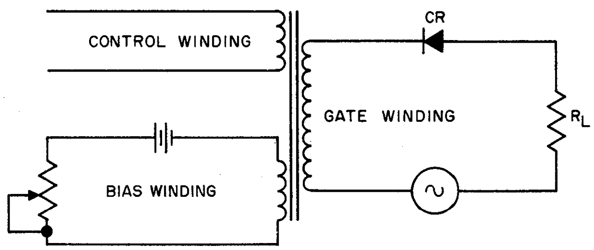


Figure 2–3. Magnetic Amplifier, Simplified Schematic

winding desaturates the core so that the resultant operating point is on the knee of the hysteresis curve of the core (Part 2, Chapter 3, Sect 1, *Theory of Operation, Power Supply System for AN/FSQ-7 and -8,* 3-82-0). A current in the control winding produces a flux which either increases or decreases the saturation of the core. Any change in core saturation changes the impedance of the windings on the core. Since the gate winding is in series with the load across an a-c source, changing the saturation of the core changes the impedance of the gate winding. As the impedance of the gate winding varies, a larger or smaller current flows from the a-c source to the load. This action produces an output voltage which varies with the control-winding current. Normally, the a-c output of a magnetic amplifier is rectified and passed through the load as d-c.

2.3.3 Buck-Boost Action

2.3.3.1 Zero Volts Amplidyne Output

Two magnetic amplifiers are used in buck-boost action in the field-control chassis. Each magnetic amplifier provides a d-c output current for an amplidyne field winding. The magnetic fluxes produced by each field winding are opposing and cancel each other when no control current is provided to the field-control chassis. When a control signal is applied to the field-control chassis, the current through one field winding is increased and the current through the other is decreased. The resulting excitation flux produced in the amplidyne causes the amplidyne output to vary with the control signal.

As shown in figure 2–4, the field-control chassis contains two magnetic amplifier circuits. Each circuit consists of a full-wave rectifier and saturable core with two gate windings (one winding in each leg of the full-wave rectifier). A single amplidyne field winding is the load of the two gate windings. The input voltage to the amplifier circuits is regulated, single-phase, 60-cycle, 120Vac. Transformer T1 isolates the two circuits. Assuming the instantaneous input polarity shown in figure 2–4, the *electron* current of T1 is rectified and flows through gate windings A2-A1 of L1, meter M1 and one amplidyne field winding. At the same time, the electron current in the circuit of L2 is rectified and flows through meter M1, the other amplidyne field winding, and gate winding B1-B2 of L2. If the impedance of gate winding A1-A2 exactly equals that of B1-B2, the current flowing through each gate winding and amplidyne field winding will be equal. Since the magnetic flux produced in one field winding would then exactly equal and oppose that produced in the other field winding, the resulting excitation flux would be zero, and the amplidyne output would also be zero.

Note

A distinction is made between zero amplidyne output and no amplidyne output. With zero output, the amplidyne motor and generator are rotating, but the field-control circuits prevent the generator from producing an output voltage. With no output, the motor, generator, and control circuits are de-energized.

When the instantaneous input polarity is the reverse of that assumed above, gate winding B1-B2 of L1 provides the current previously supplied by gate winding A1-A2. The current passing through the amplidyne field winding is in the same direction regardless of the gate winding supplying it. In a similar manner, the other amplidyne field winding current is supplied by gate winding A1-A2 of L2.

Bias for L1 and L2 is supplied by a —30Vdc input to the bias winding of each reactor. The operating point of each core is adjusted by a separate bias-control potentiometer. These potentiometers are adjusted to provide equal current flow in each circuit, and magnetic-amplifier-output voltage (operating point) of 40 to 50Vdc as measured from A1 to B2 of each reactor.

2.3.3.2 Excursion Voltage Amplidyne Output

An excursion voltage is obtained by applying a control signal to the regulation (control) windings of L1 and L2. The regulation windings are connected so that a control signal causes the output of one magnetic amplifier to decrease and the output of the other to increase. Assume the control signal shown in figure 2–4 is applied to the control chassis. This control signal causes an increase in saturation in the core of L1, and a decrease in the impedance of the gate windings. A greater current will now flow through this magnetic-amplifier circuit to the associated amplidyne field winding. This current in turn causes a greater excitation flux to be produced by this field winding.

In a similar manner, the control signal causes a decrease in the saturation of the core of L2, and an increase in the impedance of the gate windings of L2. The increased impedance of the gate windings of L2

causes a smaller current to flow in the amplidyne field winding associated with L2. This decreased current, in turn, decreases the excitation flux produced by this field winding.

The resultant flux produced by this buck-boost action has a mganitude and direction which is determined by the control signal.

2.4 ZERO-SENSE CHASSIS

2.4.1 General

The zero-sense chassis serves two functions: It connects the amplidyne output-interlock circuit (par. 2.5.10.4 and 2.5.10.5) to the amplidyne when the amplidyne output exceeds 0.75V, and it permits an excursion to be started only if the amplidyne output is zero ±0.75V.

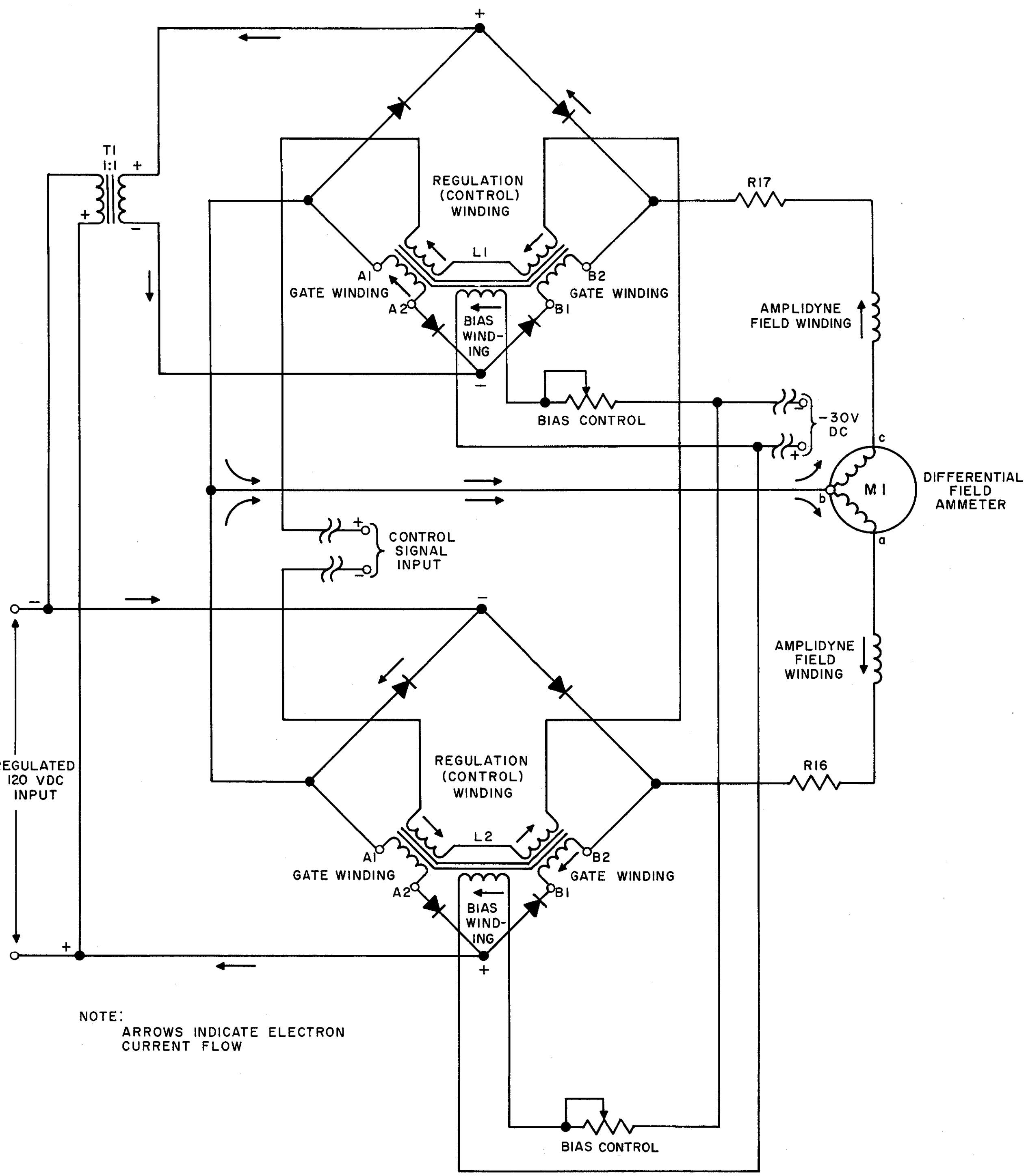


Figure 2–4. Typical Field-Control Chassis, Simplified Schematic Diagram

Note

The following discussion is applicable to both the duplex and the simplex MC systems. The designations for the components in the simplex system are given in brackets. The logic references applicable to the simplex system follow the reference to the duplex-system logic drawing.

2.4.2 Theory of Operation

The zero-sense chassis (5.5.9.1, sect. 2 or S 5.5.9.1, sect. 2) consists of two diodes, a variable resistor, a lamp, two magnetic amplifiers, and plus-excursion and minus-excursion relays. The zero-sense chassis is connected to the output of the amplidyne between amplidyne output and amplidyne neutral.

In operation, the amplidyne output voltage is dropped across a zero-sense circuit which consists of a lamp and a diode/resistor network. The lamp acts as a nonlinear resistor and the diodes limit the voltage across the potentiometer. When the amplidyne output is close to zero, the lamp resistance is low and most of the voltage drop is across the diode/resistor network. As the amplidyne output increases, the lamp resistance increases so that most of the voltage drop is across the lamp. This circuit arrangement is rugged enough to protect the diodes from high currents while still maintaining the necessary sensitivity to detect an amplidyne output of zero ±0.75V.

The magnetic amplifiers in the zero-sense chassis control the status of plus- and minus-excursion relays 63A5(K1) [58A5(K1)] and 63A5(K2) [58A5(K2)], respectively (5.5.9.1, sect. 1 or S 5.5.9.1, sect. 1). The magnetic amplifier gate-winding voltage is supplied by the 30V output of transformer 63A5(T1) [58A5(T1)]. The regulation windings control the current flow in the gate windings. The voltage developed across the diode/resistor network determines the current in the regulation windings. Potentiometer 63A5(R1) [58A5-(R1)] is adjusted so that ±0.75V at the regulation winding will cause the current in the gate windings to drop either relay 63A5(K1) [58A5(K1)] or 63A5(K2) [58A5(K2)].

The polarity of the voltage across the potentiometer 63A5(R1) [58A5(R1)] is the same as that of the excursion voltage. The regulation windings are wound so that a negative excursion causes a high impedance in the gate windings of magnetic amplifier XAM2 which causes relay 63A5(K2) [58A5(K2)] to drop. A positive excursion causes a high impedance in the gate winding of magnetic amplifier XAM1 which causes relay 63A5-(K1) [58A5(K1)] to drop.

When no excursion is applied (amplidyne output is 0 ±0.75V), both excursion relays are energized, and a circuit is completed to zero-sense relay 63A14AA9 [58A14AA9] (5.5.1.1, sect. 9 or S 5.5.1.1, sect. 10). Contacts of this relay permit —48Vdc to be applied to the cam-start circuits to allow an excursion to be initiated.

When the amplidyne output exceeds 0 ±0.75V, one of the excursion relays drops and the amplidyne output is connected to the amplidyne output interlock circuit and to the amplidyne-control voltage monitor (5.5.9.1, sect. 2 or S 5.5.9.1, sect. 2).

2.5 TYPICAL AMPLIDYNE AND FIELD-CONTROL CHASSIS OPERATION

2.5.1 Introduction

This paragraph describes the operation of the control chassis and the amplidyne. The typical operation includes the application of a reference-input voltage to the control chassis; the control of the field-winding current, bias control, regulation control, correspondence compounding, magnetic-amplifier stability, system overshoot; and output voltage circuits (fig. 2–5, foldout).

2.5.2 Application of Reference Input Voltage

Two identical reference-input voltage power supplies are used in each MC system. One supply furnishes a +125Vdc reference; the other furnishes a —125Vdc reference. The theory of operation of these supplies is discussed in Appendix A.

The reference input voltage is applied to the field-control chassis through contacts 4a-4c of field-control relay 63A7(K1) [58A7(K1)] (5.5.9.1, sect. 11 or S 5.5.-9.1, sect. 10). When a reference voltage is applied at reference input, the voltage from amplidyne neutral to reference input across resistor 63A7(R2) [58A7(R2)] is compared directly with the amplidyne output. Any difference in voltage between amplidyne output and reference input causes a current to flow through resistor 63A7(R9) [58A7(R9)], GAIN control potentiometer 63A7(R3) [58A7(R3)], and the regulation (control) windings F2-F1 and F4-F3 of both magnetic amplifiers.

Note

The arrows shown on the windings of the magnetic amplifiers (5.5.9.1 or S 5.5.9.1) indicate the direction of *conventional* current flow that would produce an increase (positive polarity) in the output voltage. These arrows point in the *opposite direction* to the *electron* flow (shown in fig. 2–5) that would cause an increased output.

The current through the regulation windings produces a buck-boost action by increasing the saturation of one magnetic core and simultaneously decreasing the saturation of the other magnetic core. Changing the saturation of the magnetic core changes the impedance of the windings of the core (par. 2.3.2).

2.5.3 Control of Amplidyne Current

The output of the field-control chassis is taken from windings A1-A2 and B1-B2 of each magnetic amplifier. The output is rectified by rectifiers 63A7(CR1) [58A7(CR1)], (CR2), (CR3), and (CR4). The rectified output is applied to amplidyne control fields 77F4-77F3 [78F4-78F3] and 77F1-77F2 [78F1-78F2] (5.5.9.1, sect. 8 or S 5.5.9.1 sect. 7).

When no reference-input signal is applied to the field-control chassis, the current through the two amplidyne field windings is approximately zero. The ammeter indicates the difference between the currents in the amplidyne fields and the direction of the resultant current.

When a reference voltage is applied, the impedance of the gate windings A1-A2 and B1-B2 of one magnetic amplifier increases, causing a voltage drop greater than the adjusted 40 to 50V. Consequently, the voltage available for the associated amplidyne field winding (the load of the magnetic amplifier) is reduced and the current through that field winding decreases. The opposite action (of the buck-boost operation) occurs in the other magnetic amplifier, providing a greater current to the associated amplidyne field winding. The current difference, shown on DIFFERENTIAL FIELD ammeter 63A7(M1) [58A7(M1)], provides the required excitation flux.

2.5.4 BIAS Control

BIAS potentiometers 63A7(R4) [58A7(R4)] and 63A7(R5) [58A7(R5)] are used to adjust the current through the bias windings of saturable reactors 63A7-(L1) [58A7(L1)] and 63A7(L2) [58A7(L2)], respectively. Resistors 63A7(R7) [58A7(R7)] and 63A7(R6) [58A7(R6)] prevent the bias current (supplied by the external —30Vdc bias source) from excessively biasing L1 and L2, respectively.

2.5.5 Regulation Control

In normal operation, the reference-input voltage is initially shorted by contacts of reference-input relay 63A14J2 [58A14J2] (5.5.8.1, sect. 2 or S 5.5.8.1, sect. 5). The regulation circuit is adjusted by GAIN potentiometer 63A7(R3)[58A7(R3)] (5.5.9.1, sect. 10 or S 5.5.9.1, sect. 10). The resistance in this circuit and the sum of resistor 63A7(R9) [58A7(R9)] and potentiometer 63A7(R3) [58A7(R3)] determines the gain of the amplidyne and hence the time of response to a sudden change in reference input.

2.5.6 Correspondence Compounding

A large amount of compounding (positive feedback) is used to provide for correspondence between the reference-input voltage and the amplidyne-output voltage. The difference between the input and the output voltage is applied across the voltage-divider network formed by resistors 63A7(R1) [58A7(R1)] and 63A7-(R18) [58A7(R18)]. The voltage at the center point of this divider is applied to the compounding winding F7-F8 of each magnetic amplifier through CORRESPONDENCE potentiometer 63A7(R12) [58A7(R12)]. The setting of 63A7(R12) [58A7(R12)] determines the amount of current applied to the compounding windings. This current is kept small enough to provide only a small portion of the total excitation. This arrangement is sufficient to hold a voltage under load and to hold a zero voltage with zero reference input.

2.5.7 Magnetic Amplifier Stability

Stability of the magnetic amplifier is provided by parallel resistors 63A7(R15) [58A7(R15)] in series with filter capacitor 63A7(C4) [58A7(C4)]. Capacitor 63A7(C6) [58A7(C6)] is a blocking capacitor. STABILITY potentiometer 63A7(R11) [58A7(R11)] adjusts the magnitude of the current applied to stability windings F9-F10 and F11-F12 on each saturable core.

2.5.8 Overshoot

When a reference-input voltage is applied, the amplidyne output voltage momentarily tends to exceed the required amount by several volts. To prevent this overshoot voltage, a presensing signal is applied from amplidyne neutral through OVERSHOOT potentiometer 63A7(R10) [58A7(R10)], resistor 63A7(R8) [58A7(R8)], and capacitors 63A7(C1) [58A7(C1)], 63A7(C2) [58A7(C2)], and 63A7(C3) [58A7(C3)].

Note

The capacitors in the overshoot circuit may or may not be connected. The capacitance in this circuit acts as a coarse adjustment for the current. The potentiometer acts as a fine adjustment. Resistor 63A7(R8) [58A7(R8)] is the low-resistance limit.

The overshoot circuit passes the transient d-c signals, which are proportional to rate of rise of input voltage, to the regulation winding. The direction of the presensing signal opposes the direction of input signal and provides overshoot control.

2.5.9 Amplidyne Output Circuits

The amplidyne output is filtered by a bank of capacitors connected across the output terminals (5.5.9.1, sect. 6 or S 5.5.9.1, sect. 6). The filtered output is connected to the zero-sense chassis through the diode/resistor network (par. 1.4.2) and to the selected MC voltage line through contacts of an MC voltage contactor.

2.5.10 Protective Circuits

2.5.10.1 General

Divider relays and an interlock protect the amplidyne and field-control chassis from damage in case of

reference-voltage power supply malfunction. The circuits serviced by the amplidyne are protected by an interlock which prevents the amplidyne from applying a voltage greater than the safe limits of the selected circuit.

2.5.10.2 Divider Relays

The divider relays disconnect the reference-input voltage from the amplidyne control circuitry if an open circuit is detected in the reference-input voltage divider network (fig. 2–6). These relays are current relays.

Divider-plus relay 63A14C4 [58A14C4] and divider-minus relay 63A14C5 [58A14C5] are energized during the start-amplidyne sequence when the contacts of the ±125V interlock relay 63A14J1 [58A14J1] apply 125Vdc to the voltage-divider networks (5.5.8.1, sect. 6 or 5.5.8.1, sect. 9). Divider relay 63A14C3 [58A14C3] is energized when a safe-limit selection is made in the calculator mode.

Each of the divider relays is energized by current through the associated divider network. If an open circuit develops in any network, the associated relay is de-energized. The contacts of the de-energized relay open the circuit to reference-input relay 63A14J2 [58A14J2] and this relay drops. The contacts of relay 63A14J2 [58A14J2] transfer to disconnect the reference input from the faulty divider network and to connect the reference input to amplidyne neutral.

2.5.10.3 Reference Input Voltage Interlocks

A. OPEN CIRCUIT INTERLOCKS

FIELD CONTROL relay 63A7(K1) [58A7(K1)] (5.5.1.1 or S5.5.1.1) is held energized by contacts of

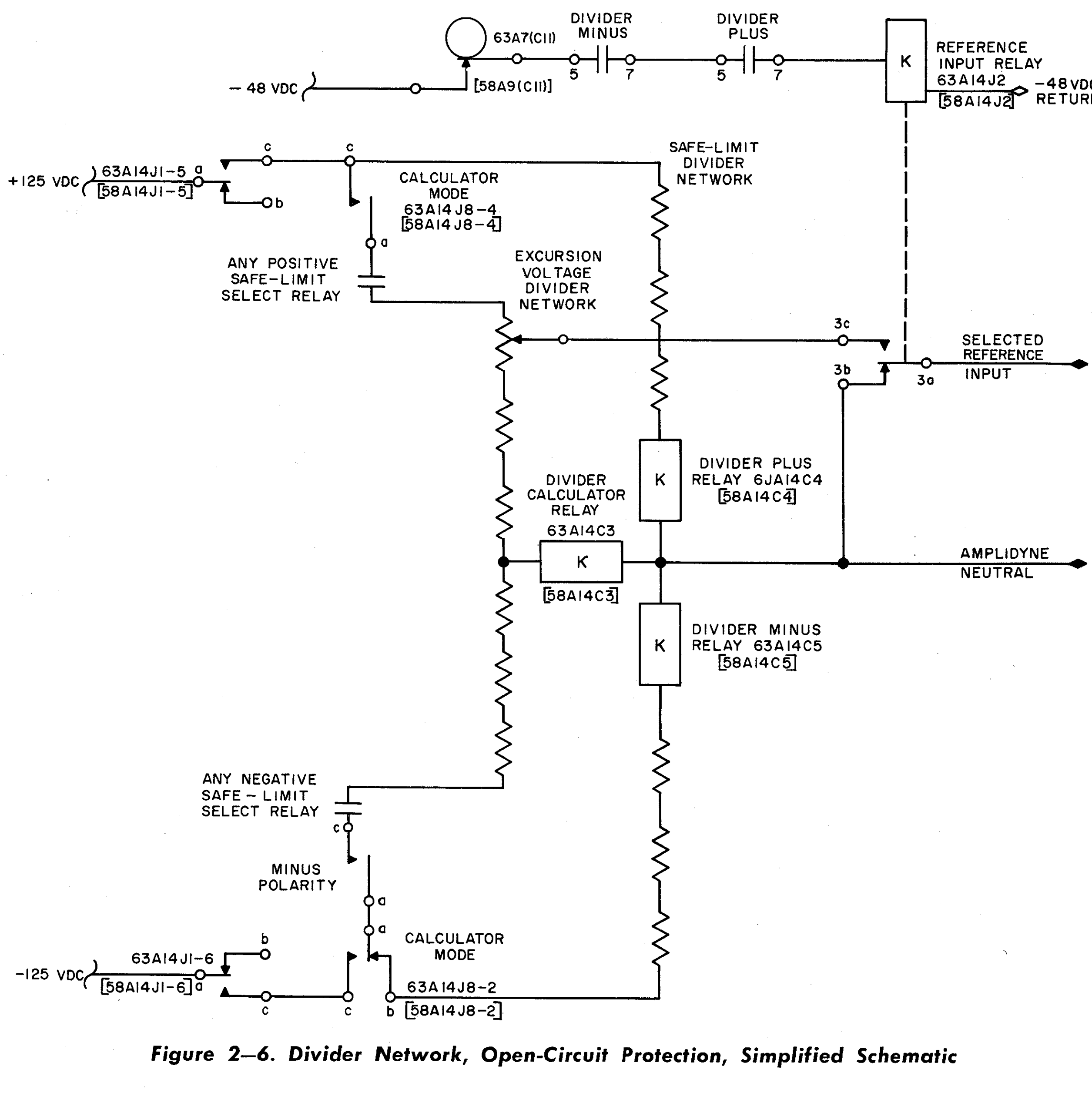


Figure 2–6. Divider Network, Open-Circuit Protection, Simplified Schematic

CB's 63A7 [58A7] (CB2), (CB3), and (CB4), the WARM UP TIMER 63A14D5 [58A14D5], MMS (magnetic motor starter), contacts 10-11 of AMPLIDYNE ON relay 63A14D6 [58A14D6], AMPLIDYNE MOTOR AUX CONTACT CB 19, and AMPLIDYNE CONTROL AUX CONTACT CB6 (fig. 2–7).

Note

CB's 19 and 6 do not appear in simplex equipment.

If any one of these relays or CB's opens, FIELD CONTROL relay 63A7(K1) [58A7(K1)] is de-energized and interrupts the regulated 120Vac, —30Vdc-bias, and reference-input circuits. The output of both magnetic amplifiers will fall and the amplidyne output will approach zero.

In the event of an open circuit in the reference input, resistor 63A7(R2) [58A7(R2)] provides a d-c suicide path so that the amplidyne output will approach zero rather than a maximum (5.5.9.1, sect. 10 or S 5.5.9.1, sect. 10).

B. VOLTAGE VARIATION INTERLOCK

The reference-input voltage is disconnected from the amplidyne control circuit whenever the output of a reference voltage supply varies by 10 percent. In normal operation, the moving arms of the voltage monitors are centered between the stationary contacts by the voltages across the moving coil (fig. 2–8). Relay 63A14D3 [58A14D3] (±125V trip) is normally energized and ±125V interlock relay 63A14J1 [58A14J1] is energized through the transferred contacts of relay 63A14D3 [58A14D3].

A variation in the reference voltage source of 10 percent of nominal voltage causes the moving coil of the voltage monitor to bring the moving arm in contact with one of the stationary contacts (5.5.8.1, sect. 7 or S 5.5.8.1, sect. 10). When either contact closes, —48Vdc is applied to both sides of the coil of ±125V-trip relay 63A14D3 [58A14D3]. When this interlock relay drops, contacts open to cause the following actions:

a. Contacts 5a-5c and 6a-6c open to disconnect each 125Vdc supply from the reference input control circuitry (5.5.8.1, sect. 6 or S 5.5.8.1, sect. 9).
b. Contacts 3a-3c (5.5.1.1, sect. 1 or S 5.5.1.1, sect. 2) open to drop relay 63A14J2 [58A14J2]. Contacts 3a-3b of 63A14J2 [58A14J2] close to transfer the reference input of the field control chassis to the potential of amplidyne neutral (5.5.8.1, sect. 1 or S 5.5.8.1, sect. 5).
c. Contacts 2a-2c open the circuit to extinguish the READY lamp at the MC control panel.

2.5.10.4 Duplex Amplidyne Output Interlock

The amplidyne output interlock in duplex MC systems causes the excursion voltage to go to zero if the amplidyne output voltage exceeds the selected safe-voltage limit. The relays of this circuit are energized during the start-amplidyne sequence.

When a positive excursion is applied, the amplidyne output voltage causes the zero-sense chassis to drop the plus-excursion relay. The contacts of the de-energized relay connect the moving coil of the voltage monitor to amplidyne neutral (fig. 2–9). The contacts of the energized minus-excursion relay connect the other side of the moving coil to the amplidyne output through a resistor network (5.5.9.1, sect. 3). The resistor (determined by the safe limit selected) is connected in series with the moving coil and limits the current so that the moving coil will close the moving contact only if the amplidyne output voltage exceeds the safe

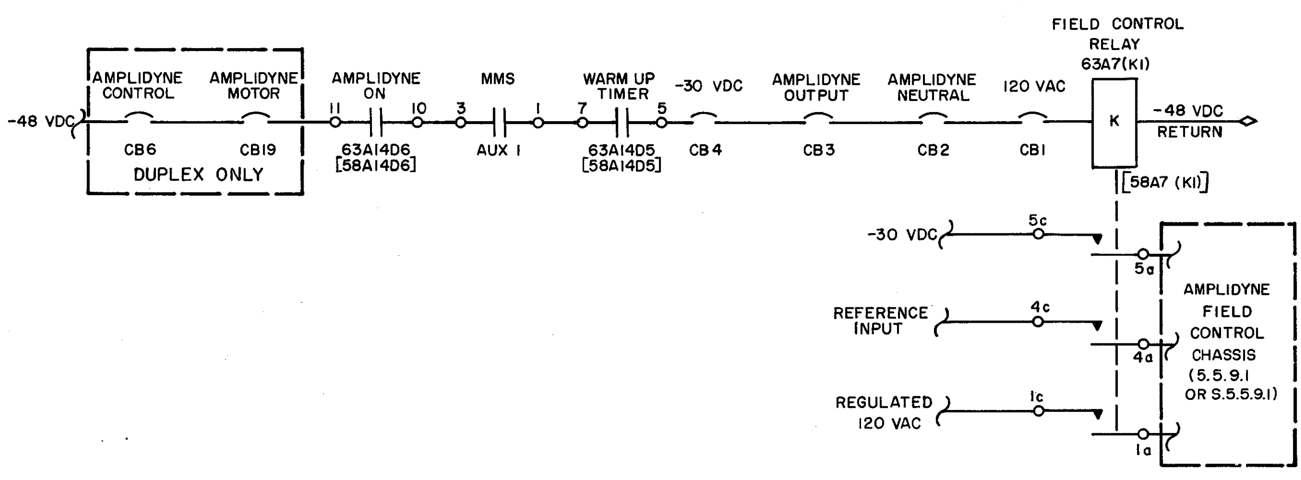


Figure 2–7. Open-Circuit Interlock, Simplified Schematic

limit selected for the circuit under test. When a negative excursion is applied, the de-energized minus excursion relay connects the moving coil to amplidyne neutral through the safe-limit resistor.

If the voltage monitor makes contact with the stationary contact, relay 63A14D4 is de-energized. Closed contacts 5-7 of relay 63A14D4 open the circuit to amplidyne output interlock relay 63A14H3 and this relay drops (5.5.9.1, sect. 2). Closed contacts 3a-3c of relay 63A14H3 open to interrupt the circuit to amplidyne fail contactor 63A12F (5.5.9.1, sect. 10). When the amplidyne fail contactor is de-energized, the following actions occur:

a. Contacts 1a-1c of relay 63A12F open the 120Vac input to the field-control chassis, and the zero-sense chassis is de-energized (5.5.9.1, sect. 11).
b. Contacts 2b-2b close to disconnect the excursion voltage from the load circuit by shorting the amplidyne output (5.5.9.1, sect. 7).
c. Contacts 4a-4b close to discharge the filter capacitors into the amplidyne neutral circuit.

In addition to dropping amplidyne fail contactor 63A12F, the contacts of de-energized amplidyne output interlock relay 63A14H3 perform the following functions:

a. Contacts 5a-5c open to drop reference input relay 63A14J2 and connect the reference input voltage to amplidyne neutral (5.5.1.1, sect. 1, and fig. 2–7).
b. Contacts 2a-2b close to initiate an excursion-stop sequence (5.5.1.1, sect. 3).
c. Contacts 3a-3b close to illuminate the AMPLIDYNE SENSITROL alarm lamp on the MC control panel (5.5.11.1, sect. 11).
d. Contacts 1a-1c open to disable the amplidyne start circuit (5.5.1.1, sect. 7).

2.5.10.5 Simplex Amplidyne Output Interlock

The simplex amplidyne output interlock causes the excursion voltage to be removed from the load circuits if the amplidyne output voltage exceeds the selected safe-limit voltage. The relays of this circuit are energized during the power-on sequence for the standby power system and the amplidyne-start sequence (fig. 2–10).

When an excursion is applied, the amplidyne output voltage causes the zero-sense chassis to drop one of the excursion relays. The contacts of the de-energized relay connect the moving coil of the voltage monitor to amplidyne neutral. The contacts of the ener-

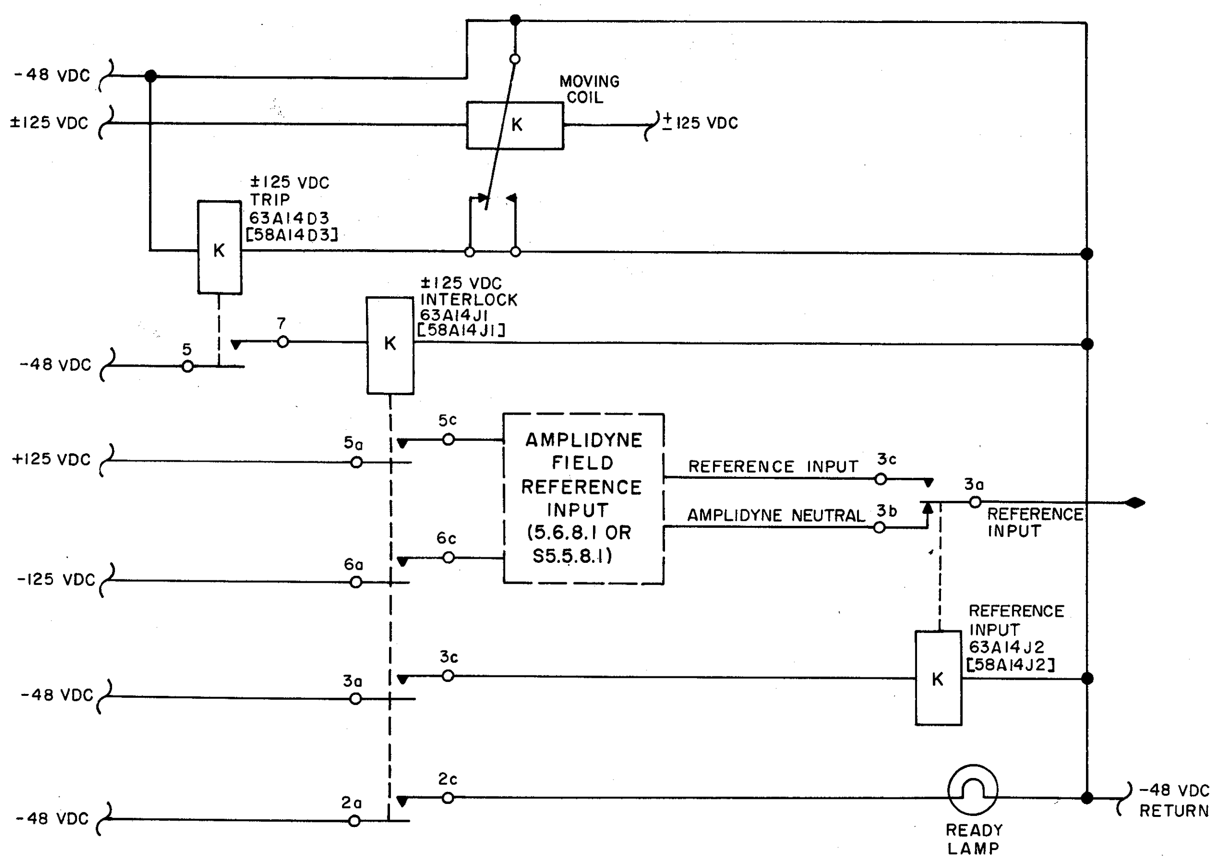


Figure 2–8. Voltage Variation Interlock Circuit, Simplified Schematic

gized excursion relay connect the other side of the moving coil to the amplidyne output through a resistor network (S 5.5.9.1, sect. 3). The resistor (determined by the safe limit selected) is connected in series with the moving coil and limits the current so that the moving coil will close the moving contact only if the amplidyne output exceeds the safe limit selected for the circuit under test.

If the voltage monitor makes contact with stationary contact, relay 58A14D4 is de-energized. Contacts 5-7 of relay 58A14D4 open the circuit to amplidyne output interlock relay 58A14H3, and this relay drops (S 5.5.9.1, sect. 2). When relay 58A14H3 is de-energized, the following actions occur:

a. Contacts 3a-3b close to illuminate the AMPLIDYNE SENSITROL alarm lamp.

b. Contacts 5a-5c open to de-energize reference input relay 58A14J2 and connect the reference input voltage to amplidyne neutral.

c. Contacts 3a-3c open to de-energize d-c and MC CB interlock relay 58B6G4 (S 5.4.10.2, sect. 4).

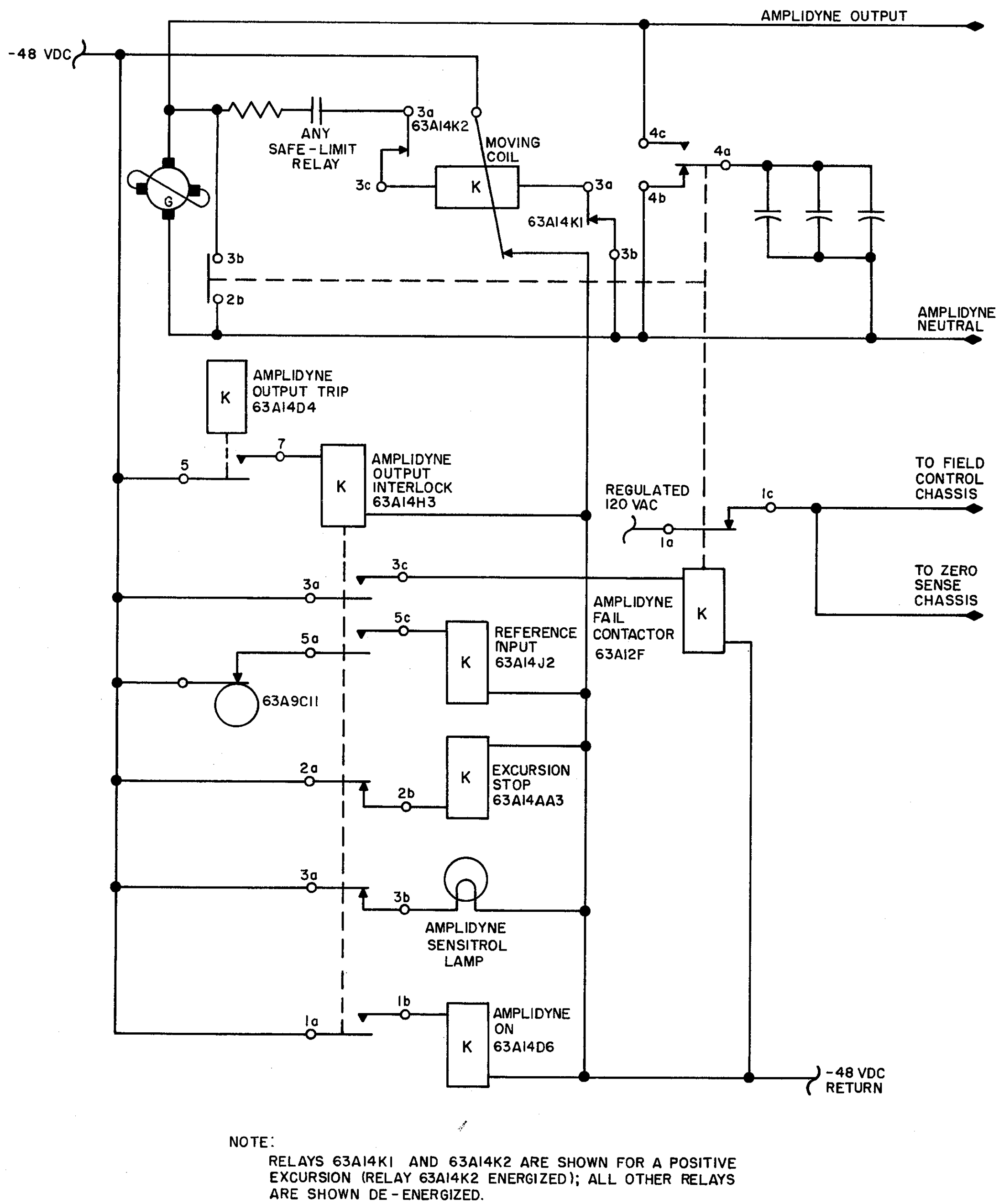


Figure 2–9. Duplex Amplidyne Output Interlock Circuit, Simplified Schematic

When relay 58B6G4 is de-energized, its contacts 2a-2c and 1a-1c open. Each set of contacts is in the energizing circuit of a d-c service-voltage relay. One d-c service-voltage relay is associated with each simplex power system and is energized when the associated system is in standby status. Relay 58B6D2 is associated with system C; relay 58B2D2 with system D. Since only one system may be designated standby at any time, only one of these relays is energized during MC operations. When the energized d-c service-voltage relay is de-energized, the following actions occur:

a. Contacts 3-4 open to de-energize excursion-on and excursion-off relays (S 5.4.10.2, sects. 5, 6, and 7).

b. Contacts L1-T1 through L5-T5 open to disconnect the d-c voltages from those channels that are in the standby-MC status.

Note that the d-c voltages are not removed from channels in the standby status. These channels receive power from unit 56 rather than unit 58, and are therefore not affected by a power removal in unit 58.

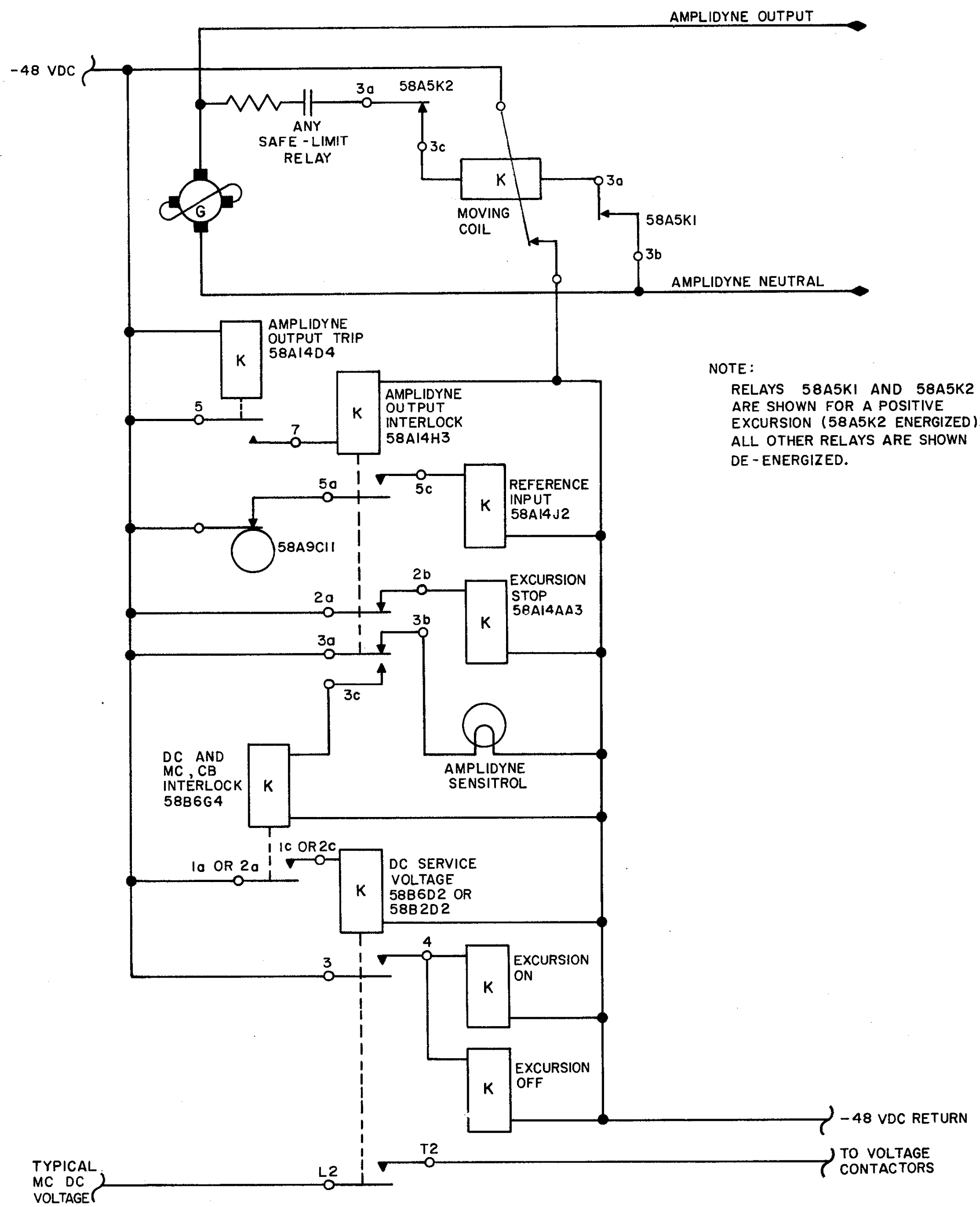


Figure 2—10. Simplex Amplidyne Output Interlock Circuit, Simplified Schematic

CHAPTER 3
MC CONTROL MODES

3.1 INTRODUCTION

Marginal checking is normally performed on equipment in the standby status. The status of duplex equipment is determined at the duplex switching console. The status of simplex equipment is determined by the setting of the simplex power switch and the setting of the unit status switch associated with the paricular channel. Marginal checking voltages are distributed only to the simplex units whose unit status switches are in the STANDBY-MC status. The functions of the unit status switch are discussed in *Theory of Operation, Power Supply System for AN/FSQ-7 and -8,* 3-82-0.

The portion of the equipment to be marginally checked and the voltage excursion to be applied may be controlled automatically or manually. The mode of control is selected at the MC control panel of the maintenance console associated with the system to be tested. There are three modes of control: calculator, manual, and satellite.

3.2 CALCULATOR MODE

During calculator-mode operations, the MC system is controlled automatically by programmed instructions from the standby computer. The speed of the calculator mode makes it the most advantageous type of control for routine testing. The slower-speed manual and satellite modes are used to investigate specific circuits found to be faulty during calculator-controlled tests.

When MC operations are controlled by the computer, only the following maintenance console controls remain effective:

a. STOP EXCURSION

b. STOP AMPLIDYNE

c. MODE SELECTOR

d. MC CONTROL TEST

For calculator control of the simplex MC system, a duplicate set of calculator control lines connects the duplex PCD unit to the simplex MC system. A relay interlock controlled by the duplex switch on the duplex switching console permits only the lines from the PCD unit of the standby computer to be connected to the simplex MC system.

It is possible to have calculator-controlled excursions on both the duplex and the simplex MC systems simultaneously. However, the simplex excursions must be applied first. If the duplex excursion is applied first, initiating a simplex excursion will stop the duplex excursion.

3.3 MANUAL MODE

In the manual mode of control, the equipment to be listed is selected by means of pushbuttons and toggle switches on the MC control panel of the maintenance console (par. 1.2, Part 3, Ch 3, and par. 1.2. Part 4, Ch 3). The voltage excursion is controlled by a potentiometer on the MC control panel and observed on a voltmeter at the same location. During this mode, all controls and pushbuttons on the MC control panel are operative.

3.4 SATELLITE MODE

The satellite mode is a variation of the manual mode. Both the satellite mode and the manual mode are the same except that in the satellite mode the voltage excursion is controlled by a portable potentiometer. The satellite mode permits maintenance personnel to control an excursion at a load unit while observing the operation of the unit on an oscilloscope. During satellite mode of control, the potentiometer on the maintenance console is inoperative.

Note

The satellite mode of control is not available at all AN/FSQ-7 and -8 sites.

CHAPTER 4
PROGRAMMING ASPECTS OF MARGINAL CHECKING

4.1 INTRODUCTION

The marginal Checking System is controlled automatically by the Central Computer during calculator-mode operations. The Central Computer is controlled by a program which instructs the computer to perform certain functions. Pertinent operating and sensing instructions and a typical control word and MC program are discussed in the following paragraphs.

4.2 MC PROGRAM INSTRUCTIONS

Six program instructions are especially applicable to the calculator mode of marginal checking. Three of these instructions are in the operate class, two are in the sense class, and one is the *Halt (HLT)* instruction. The *Operate* instructions start and stop the MC process. The *Sense* instructions interrogate an MC FF in the Central Computer to determine the status of the MC system.

Before a control word in the test register can be recognized and interpreted by the MC control system, the appropriate *Operate* instruction must be given by the program.

4.2.1 Operate Class Instructions

4.2.1.1 *Start Excursion (Per 21)* Instruction

This instruction must be programmed after the test register is loaded with an MC control word. In the MC System, the *PER 21* instruction removes the selections of the previous excursions and provides for restoring the computer program in the mode designated by bits L1-L2 of the control word after an excursion has been applied. In the Central Computer, the *PER 21* instruction causes the information held in the test-register FF's to be gated into the thyratron register. In this way the control word is stored in the calculator-MC-control relays. The instruction also resets all control flip-flops (FF's) in the Central Computer, resets all FF's in the manual data input element, and fires a thyratron which energizes a start-excursion relay.

4.2.1.2 *Stop Duplex MC Excursion (PER 22)* Instruction

This instruction causes a stop-excursion relay in the duplex MC system to be energized to stop an MC operation.

The *PER 22* instruction provides a control-clear pulse to reset the control FF's in the Central Computer and to reset all FF's in the manual data input element. In the MC system, the instruction provides for restarting the computer in the mode indicated by bits L3-L4 after the excursion is removed.

4.2.1.3 *Stop Simplex MC Excursion (PER 23)* Instruction

This instruction *(PER 23)* operates in the simplex system in the same manner as a *PER 22* instruction functions in the duplex system.

4.2.2 Sense-Class Instructions

4.2.2.1 *Sense Duplex MC Excursion On (BSN 20)* Instruction

This instruction interrogates the duplex MC FF to determine whether an excursion is being applied to the duplex MC system. The test branch of the program will be executed if the FF is set (excursion on) at the time of interrogation. The sensing process will not affect the condition of the FF.

4.2.2.2 *Sense Simplex MC Excursion On (BSN 27)* Instruction

This instruction interrogates the simplex MC FF and operates in the same manner as the *BSN 20* instruction.

The MC FF in either system is used in calculator mode. Manual-mode operations do not affect the normally-cleared FF.

4.2.3 *Halt (HLT)* Instruction

This instruction causes the Central Computer to stop executing the instructions under calculator mode. Any operation in progress, at the time the *HLT* instruction is given, is decoded and completed. When the computer is halted by this instruction, the program counter contains the address of the instruction immediately following so that restarting the computer by depressing the CONTINUE pushbutton will cause the instruction immediately following the *HLT* to be executed.

A programmed MC-restart instruction will not return the operation to the instruction following the *HLT*, but rather to test memory, core memory, load from card reader, or load from AM drums.

4.3 MC CONTROL WORD

The MC control word is a 32-bit word with specific control functions assigned to groups of bits within the word. The functions assigned to the groups of bits

are given in table 2–1. Each bit of the MC word is associated with a FF in the test register. Each FF, in turn, conditions a thyratron relay driver (RYD) which is operated by a *Stop-Excursion* or *Start-Excursion* instruction. Each group of bits within the MC word controls a different MC selection or operation. The MC control relays actuated by the MC word are the same relays actuated by controls on the maintenance console during manual control.

An MC word may start an excursion sequence (start-excursion word) or make changes in an already applied excursion (change-excursion word). The left sign (LS) bit of the word determines whether the word is a start-or-change excursion word.

TABLE 2–1. MARGINAL CHECK WORD BREAKDOWN

	LEFT WORD		
BIT	**FUNCTION**	**BINARY CODE**	**OPERATION**
LS	Start excursion	1	New start
	Change excursion	0	Change magnitude, polarity, and first restart (note 1)
1 and 2	Restart the computer program after the excursion has been applied	01	Continue from 00000
		11	Load from card reader
		00	Load from drums
		01	Continue from 00000
3 and 4	Restart the computer after the excursion has been removed	10	Continue from 20,000
		11	Load from card reader
		00	Load from drums
		01	Continue from 20,000
5 and 6	Excursion duration	00	Infinite
		01	3 seconds
		10	7 seconds
		11	30 seconds
7	Excursion polarity	0	Positive
		1	Negative
8	Spare		Note 2
9 to 12	Excursion Magnitude	0000	0V
		0001	10V
		0010	12V
		0011	14V
		0100	16V
		0101	18V
		0110	20V
		0111	25V

TABLE 2–1. MARGINAL CHECK WORD BREAKDOWN (cont'd)

LEFT WORD

BIT	FUNCTION	BINARY CODE	OPERATION
		1000	30V
		1001	35V
		1010	40V
		1011	50V
		1100	60V
		1101	70V
		1110	85V
		1111	100V
13 to 15	Voltage Group	001	+250V
		010	+150V
		011	+90V
		100	—150V
		101	—300V

RIGHT WORD

BIT	FUNCTION	BINARY CODE	OPERATION
RS to 3	MC equipment group	0000	Spare
		0001	MC-1 Memory
		0010	MC-2 Arithmetic
		0011	MC-3 Program and Control
		0100	MC-4 I/O Control
		0101	MC-5 Drums
		0110	MC-6 Displays
		1000	MC-8 Outputs
		1001	MC-9 Simplex
		1010-1111	Spares
4 to 9	Circuit-group selection	000 000	No selection
		100 000	Circuit A (note 3)
		010 000	Circuit B
		001 000	Circuit C
		000 100	Circuit D

TABLE 2–1. MARGINAL CHECK WORD BREAKDOWN (cont'd)

RIGHT WORD

BIT	FUNCTION	BINARY CODE	OPERATION
		000 010	Circuit E
		000 001	Circuit F
10 to 15	Duplex line-group selection	000 000	No selection
		100 000	Line 1
		010 000	Line 2
		001 000	Line 3
		000 100	Line 4
		000 010	Line 5
		000 001	Line 6
10 to 15	Simplex circuit group selection (MC-equipment-group 9)	000 000	No selection
		100 000	Circuit G
		010 000	Circuit H
		001 000	Circuit J
		000 100	Circuit K
		000 010	Circuit L
		000 001	Circuit M

Notes:
1. If LS is zero, then L3 through L6, L13 through L15 and RS through R15 must be zero and L1, L2, L7 and L9 through L12 must be specified.
2. Bit L8 is sometimes used for decoding purposes to indicate when the excursion should be removed (0 = 100V; 1 = 25V). This is a time-saving feature since the system is interlocked to prevent the safe-limit from being exceeded.
3. If MC-group 9 (simplex) is selected, bits R4-R9 select simplex circuits A through F. To select all simplex circuits, bits R4 through R15 must contain all one's.

4.3.1 Start-Excursion Word

If the left-sign bit of the MC word contains a one (LS–1), the MC word is a start-excursion word. A start-excursion word removes any existing selections in the MC system and selects new equipment and excursions. In a start-excursion word all information pertinent to equipment and excursion selections must be specified.

4.3.2 Change-Excursion Word

If the left-sign bit of the MC word contains a zero (LS–0), the word is a change-excursion word. A change-excursion word alters the magnitude and polarity selections of the existing excursion. The excursion duration is not changed but the excursion-duration timers are reset to zero. A change-excursion word does not provide for equipment selection nor remove previous equipment selections.

In a change-excursion word, the excursion magnitude, polarity, and restart information must be specified, even if these values are to remain unchanged. All other bits must contain zeros.

4.4 TYPICAL MC PROGRAM

A typical MC program may be divided into two interwoven routines: the executive routine, and the test routine (fig. 2–11). The executive routine loads the test routine; sets up the initial test conditions of equip-

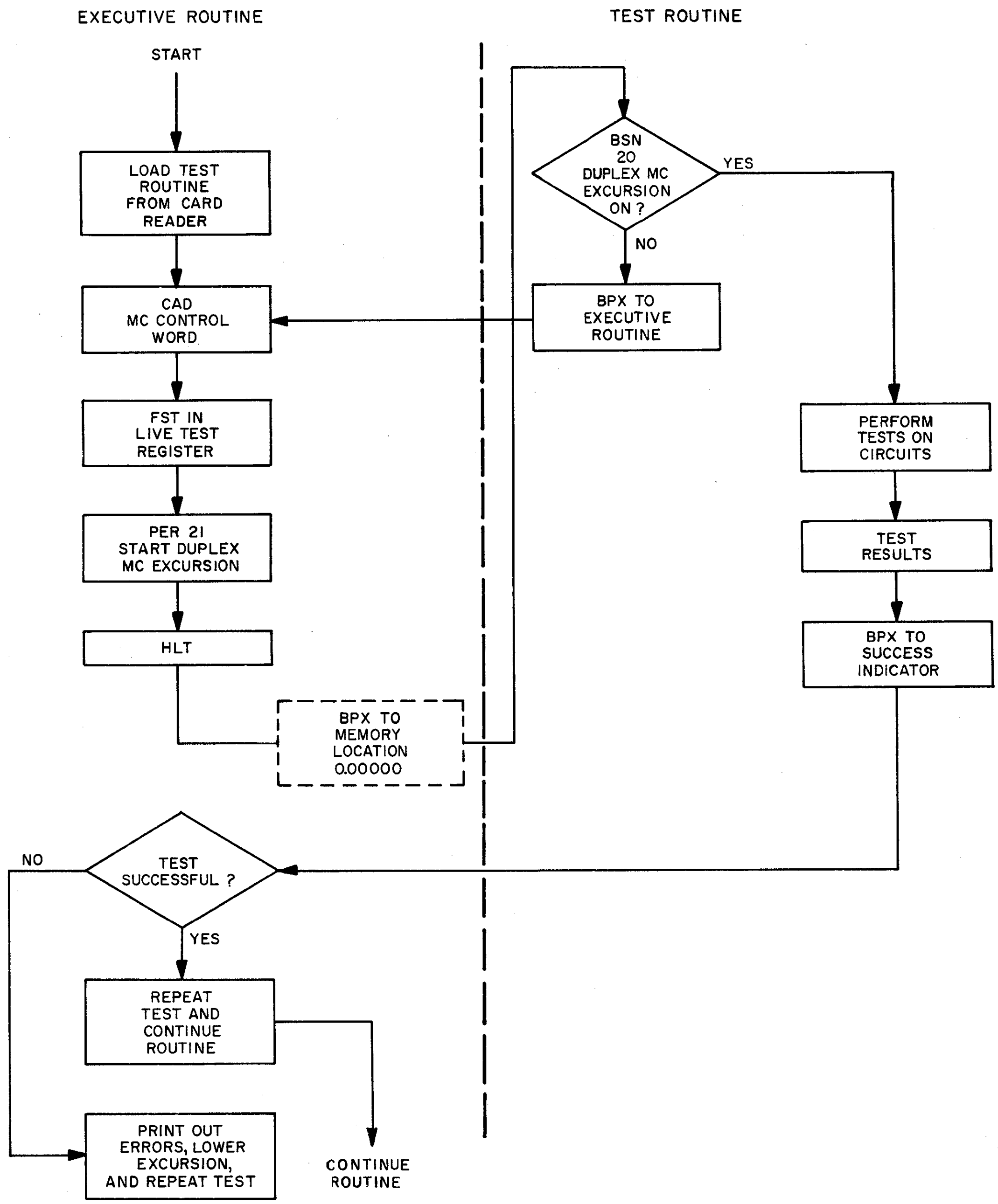


Figure 2–11. Typical MC Programs, Simplified Flow Chart

ment to be tested, excursion magnitude, and exursion duration; and checks the results of the test routine. The test routine causes the selected circuits to perform normal operations with the excursion voltages applied. Figure 2–9 is a simplified flow chart of a typical MC program. The left half of the figure contains the executive routine; the right half, the test routine.

In this typical program, the test routine is loaded into memory from the card reader. The executive routine then reads the MC control word, stores it in the live test register, gives a *PER 21* instruction, and halts. The MC system initiates a restart which branches to the *BSN 20* instruction stored in memory location 0.00000. Providing an excursion is on (*BSN 20* instruction), the test routine is begun and the required tests are made on the selected circuits. If an excursion is not on, the program branches back to the executive routine to obtain an MC word and begin an excursion.

At the end of the tests, the result is fed to the executive routine which determines the success or failure of the test. If the test failed, the excursion is lowered, the error is printed out, and the test is rerun. If the test was successful, it is repeated and the program is continued.

PART 3
DUPLEX MC SYSTEM

CHAPTER 1
INTRODUCTION

1.1 GENERAL

Part 3 describes the operation of the duplex MC system. The distribution of a typical MC d-c voltage and the control sequences are discussed. Each sequence in the operation of the system is described under one of the following major MC operations: Power On, Start Amplidyne, Start Excursion, Excursion Control, Stop Excursion, and Stop Amplidyne.

1.2 SYSTEM COMPONENTS

Each duplex MC system consists of the following components:

a. One amplidyne and its associated control circuits
b. Six MCD units containing MC relays and controls
c. Control equipment in the MC portion of the PCD unit
d. One MC control panel mounted on each duplex maintenance console
e. Other distribution components such as CB's, relays, and bus bars
f. Portable satellite control boxes (at those sites equipped for satellite marginal checking)

CHAPTER 2

DUPLEX DISTRIBUTION

2.1 GENERAL

This chapter discusses the distribution of MC voltages through a duplex MC system. Since both duplex systems are identical, the following description is applicable to both systems.

A block diagram analysis is used to show the overall arrangement of voltage distribution in a duplex MC system. A typical voltage line (+150Vdc) is traced from the power supply unit through a typical MCD unit (unit 19) to a typical load unit (unit 2).

2.2 BLOCK DIAGRAM ANALYSIS

Figure 3–1 is a simplified block diagram of the voltage distribution in a duplex MC system. Five voltage lines from the d-c power supplies are connected to the MC voltage contactors and the MC relays. These five voltages are the MC voltages (+250V, +150V, +90V, –150V, and –300V). The same five voltages are also connected between the d-c power supplies and other contacts of the MC relays. These are the non-MC voltages.

When no MC operations are being performed, the voltage contactors and MC relays distribute the non-MC voltages to the load units through one set of contacts. When MC operations are taking place, one voltage contactor in each voltage line opens and connects the amplidyne output in series with the voltage line. The amplidyne output is varied and this variation changes the MC voltage at the MC relays. The selected MC relay disconnects the non-MC voltage from the circuits in the load units and applies the MC voltage to the same circuits. All other circuits continue to be supplied with the non-MC voltages. The MC voltage is not varied until the selected MC relays are transferred.

The MC voltage contactors determine the particular d-c voltage that is to be varied. The MC relays determine the particular load circuits to be marginally

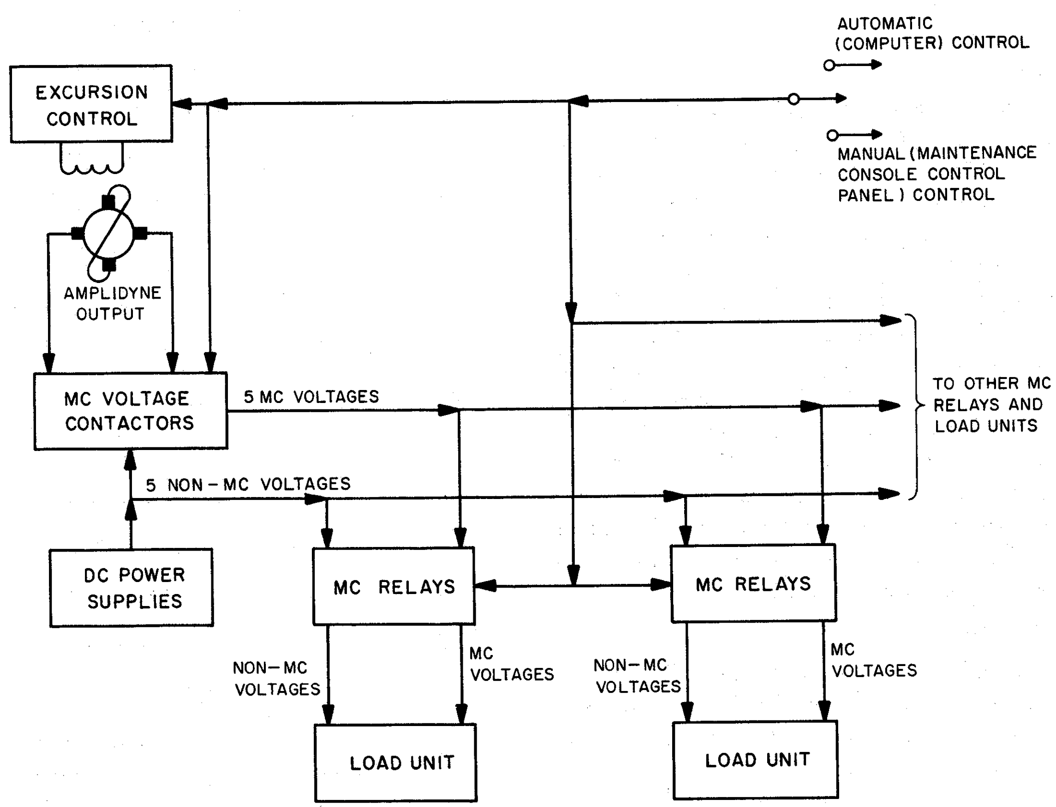


Figure 3–1. Duplex MC System, Simplified Block Diagram

TABLE 3–1. MARGINAL CHECKING D-C DISTRIBUTION

VOLTAGE	MC CB	RELAY	UNIT 19	UNIT 27	UNIT 31	UNIT 46	UNIT 59
+90	63A11A10	63A12E	63B3U2-1	63B3U4-3	63B3U8-7	63B3U6-5	63B3U10-9
–150	63A11A9	63A12D	63B3V2-1	63B3V4-3	63B3V8-7	63B3V6-5	63B3V10-9
+150	63A11A8	63A12C	63B3T2-1	63B3T4-3	63B3T8-7	63B3T6-5	63B3T10-9
+250	63A11A7	63A12B	63B3R2-1	63B3R4-3	63B3R8-7	63B3R6-5	63B3R10-9
–300	63A11A6	63A12A	63B3W2-1	63B3W4-3	63B3W8-7	63B3W6-5	63B3W10-9

Note: Contacts R, T, U, V, and W for each unit are five poles of separate knife switches.

checked. The excursion-control circuits in the amplidyne input determine the direction and magnitude of the MC voltage variation.

2.3 D-C DISTRIBUTION

2.3.1 General

The MC voltages are generated by the d-c power supplies in unit 60. From unit 60, the d-c voltages are distributed to the load units through the PCD unit and the six MCD units.

2.3.2 Power Supply Unit

The MC d-c voltages are distributed from the power-supply unit to the PCD unit in the same manner as the non-MC d-c voltages (Part 3, *Theory of Operation, Power Supply System for AN/FSQ-7 and -8,* 3-82-0).

2.3.3 PCD Unit

Each of the five MC voltages (+250V, +150V, +90V, –150V and –300V) is applied to an MC CB in the PCD unit (fig. 3–2). These CB's must be closed before the MC system can be operated. From the CB's the voltages are distributed to the MC voltage interlock contactors. During MC operations, the voltage variation produced by the amplidyne is inserted, through the MC voltage interlock contactors, into the line of the voltage to be varied. From these contactors, the MC voltages are applied to five 5-pole disconnect switches (5.3.2.1) for distribution to the MCD units. Only five sets of switches are needed because MCD unit 46 receives its MC voltages from MCD unit 29. Therefore, only one 5-pole switch is provided for both units. Table 3–1 lists the CB's, relays, and disconnect-switch contacts associated with each MCD unit.

2.3.4 MCD Units

The MCD units serve as secondary distribution points for the MC voltages. Each MCD unit contains relays, voltage contactors, and CB's for distributing the MC voltages to the load units.

Six MCD units are included in the duplex MC system. Each MCD unit is the distribution center for a group of load units. Table 3–2 lists the load units serviced by each MCD unit. Each MCD unit receives MC voltages from the PCD unit and distributes these

TABLE 3–2. MCD UNITS AND ASSOCIATED LOAD UNITS

MCD UNIT	LOAD UNIT NO.	LOAD UNIT FUNCTION
19	2	Left arithmetic
	3	Right arithmetic
	4	Instruction control
	5	Selection control
	6	Program element
	7, 8, 9	Core memory No. 1
	10, 11, 12	Core memory No. 2
	13	Magnetic tape adapter
27	23	Manual input
	24	Situation display generator
	25	Digital display generator
	30	Warning light control
29	21	Drum control
	22	Main drum
31	42	Output control
	33	Output storage
46	20	Auxiliary drum
59	32	Crosstell (common equipment)
	34	Gap filler input
	41	Long range input

Note: Units 34 and 41 are found only in AN/FSQ-7 equipment

voltages to the load units as shown in figure 3–2. The distribution in MCD unit 59 varies slightly because the MC CB's, the non-MC CB's and bus bars normally found in the load unit are in the MCD unit. With this exception, figure 3–2 is applicable to all MCD units.

Each d-c service voltage enters the MCD unit at the service-voltage bus bar. From this bus bar the voltage is distributed through single-pole CB's to a set of contacts on the service-voltage contactor. The closed contacts connect the service voltage to the non-MC voltage bus bar in the load unit (except MCD unit 59). The closed contacts also connect the d-c service voltage to the MC CB in the MCD unit. The closed MC CB applies the d-c voltage to the MC service bus bar. The voltage at this bus bar is distributed through normally closed contacts of an MC relay to the MC CB in the load unit.

The excursion voltage generated by the amplidyne enters the MCD unit at the MC input voltage bus bar. The MC CB's distribute this voltage to the MC bus bar through contacts of an MC voltage contactor. Normally open contacts of an MC relay transfer and apply the voltage to the MC CB's in the load unit during MC operations.

The MC relays use make-before-break contacts to prevent loss of voltage when the relays transfer.

In a typical distribution circuit, MCD unit 19 distributes +150Vdc to load unit 2. The MC voltage is applied through CB 19C8A9 and relay 19C6(K4) to bus bar 2Z3J21 (fig. 3–3). During MC operations, the contacts of relay 19C6(K4) are closed and those of relay 19C6(K3) are opened (fig. 3–3). This relay-contact configuration permits the MC voltage and the variation produced by the amplidyne to be fed to the bus bar in the load unit.

2.3.5 Load Unit

In load unit 2, the MC voltages are applied to bus bar 2Z3J21 (fig. 3–3). From this bus bar, the voltages are distributed to the modules of the load unit in the same manner as the non-MC voltages (Part 3, *Theory of Operation, Power Supply System for AN/FSQ-7 and -8*, 3-82-0).

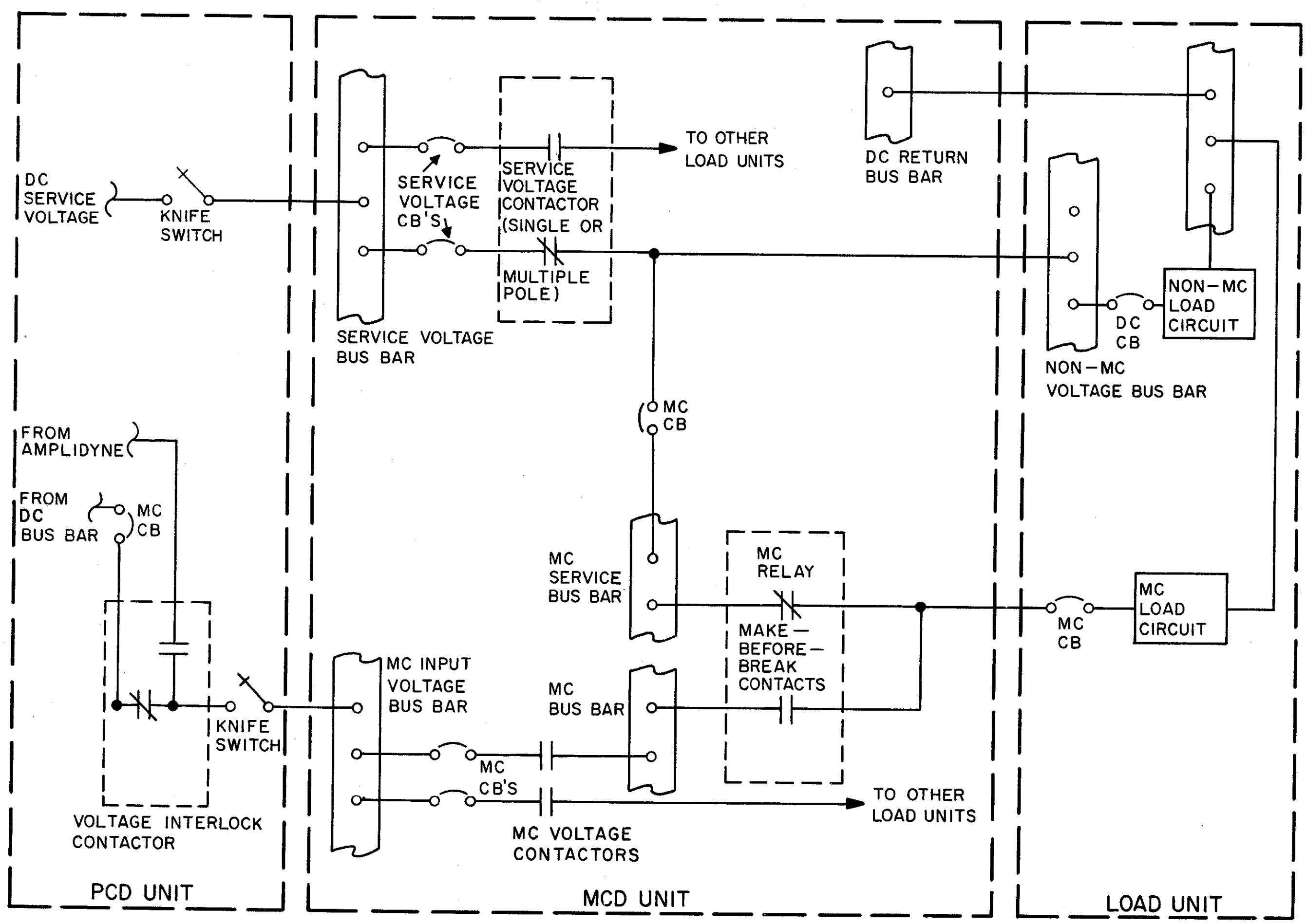


Figure 3–2. Typical D-C Distribution, PCD, MCD and Load Unit

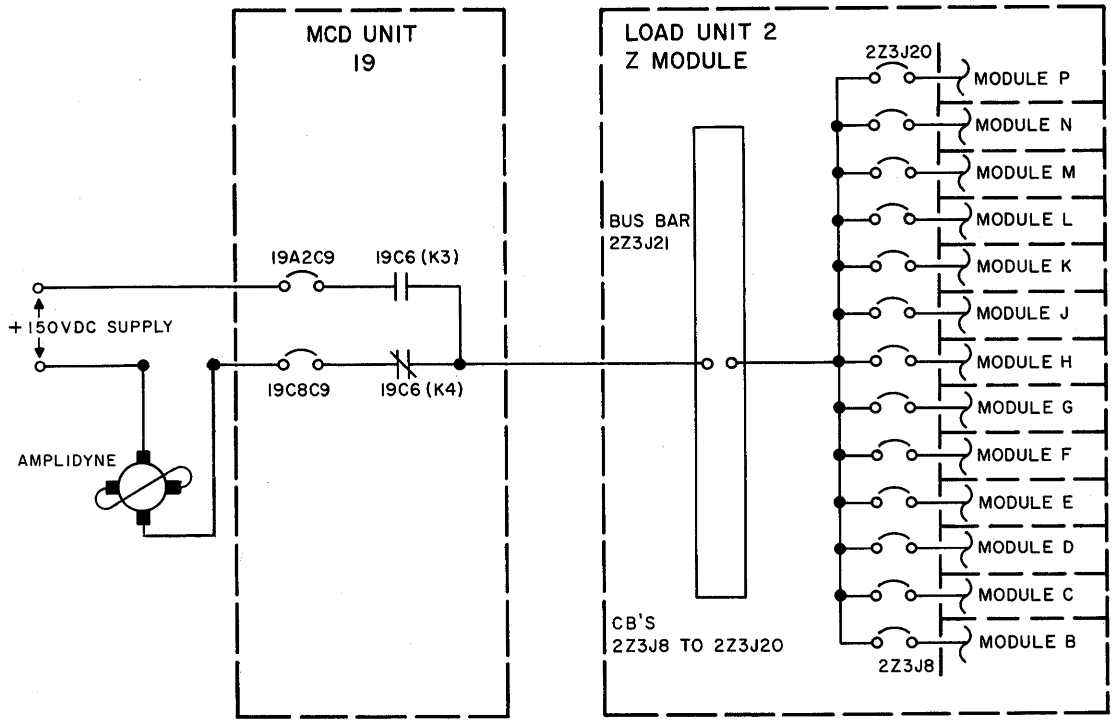


Figure 3–3. Typical MC D-C Distribution (+150V) Simplified Block Diagram

CHAPTER 3

DUPLEX CONTROL

SECTION 1

CONTROLS AND INDICATORS

1.1 INTRODUCTION

This section discusses the controls and indicators found at the duplex maintenance console and the PCD unit.

1.2 DUPLEX MAINTENANCE CONSOLE

The controls and indicators associated with the duplex MC system are located on the MC control panel (Module H) of the associated duplex maintenance console. The location of the controls and indicators is shown in figure 3–4. The functions of these controls and indicators are given in table 3–3.

1.3 PCD UNIT

Module A of the PCD unit contains controls and indicators for the associated MC system (fig. 3–5). This equipment includes amplidyne CB's, reference voltage power supplies, voltage contactors, control CB's, meters, cam timing units, and a dynamic timer. The CB's, voltage contactors, and reference voltage power supplies are discussed with the components which they control. The cam timing units, meters, and the dynamic timer are discussed below.

1.3.1 Cam Timing Units

Two cam timing units are used to control the timing of the various operations within an MC process. Cam units 63A9 and 63A10 are the two units associated with the duplex MC system.

The cam units control the timing of the various actions by opening and closing circuits at predetermined points of cam revolution. The predetermined points are designated in degrees of cam revolution from zero, rather than in degrees of revolution from the cam latch point at 245 degrees. The cams are shaped so as to open and close a circuit as many times as necessary during one complete cam revolution.

A cam unit consists of 24 cams and the contact assemblies associated with each cam. All of the cams in one unit are mounted on a common shaft and are rotated simultaneously. Each cam shaft is rotated by a cam motor through a cam clutch coupling.

Cam unit 63A9 is operated during every MC operation, regardless of the mode. Cam unit 63A10 is operated only in the calculator mode.

1.3.2 Meters

A voltmeter and an ammeter which indicate the amplidyne output are mounted on module A of the PCD unit. The voltmeter indicates the amplidyne output voltage. The ammeter is the differential field meter which indicates the amount and direction of the amplidyne field current.

Each reference voltage power supply also contains a voltmeter and an ammeter which indicate the voltage and current output of the supply.

1.3.3 Dynamic Timer and Power Pack

The dynamic timer associated with each of the cam timing units is located in module A of the PCD unit.

The primary purpose of the timer is to test the timing of the make-contact and break-contact points of the cams in the cam units. The timer may also be used to test relay contacts, CB's, and other electrical and mechanical components.

The timer utilizes neon lights that revolve at a given speed behind a transparent index dial which is divided into 360 degrees. When the timer is used, the neon lights are illuminated through the contacts of the device being tested. The neon lights, visible through the transparent dial, indicate the time (in degrees) at which the contacts of the device being tested close and open.

A portable power pack that provides power for the dynamic timers is connected to a plug at the timer. For a complete discussion of the dynamic timer and the power pack, and the methods of making tests, refer to *Dynamic Timer and Power Pack,* T.O. 31P2-2FSQ7-151.

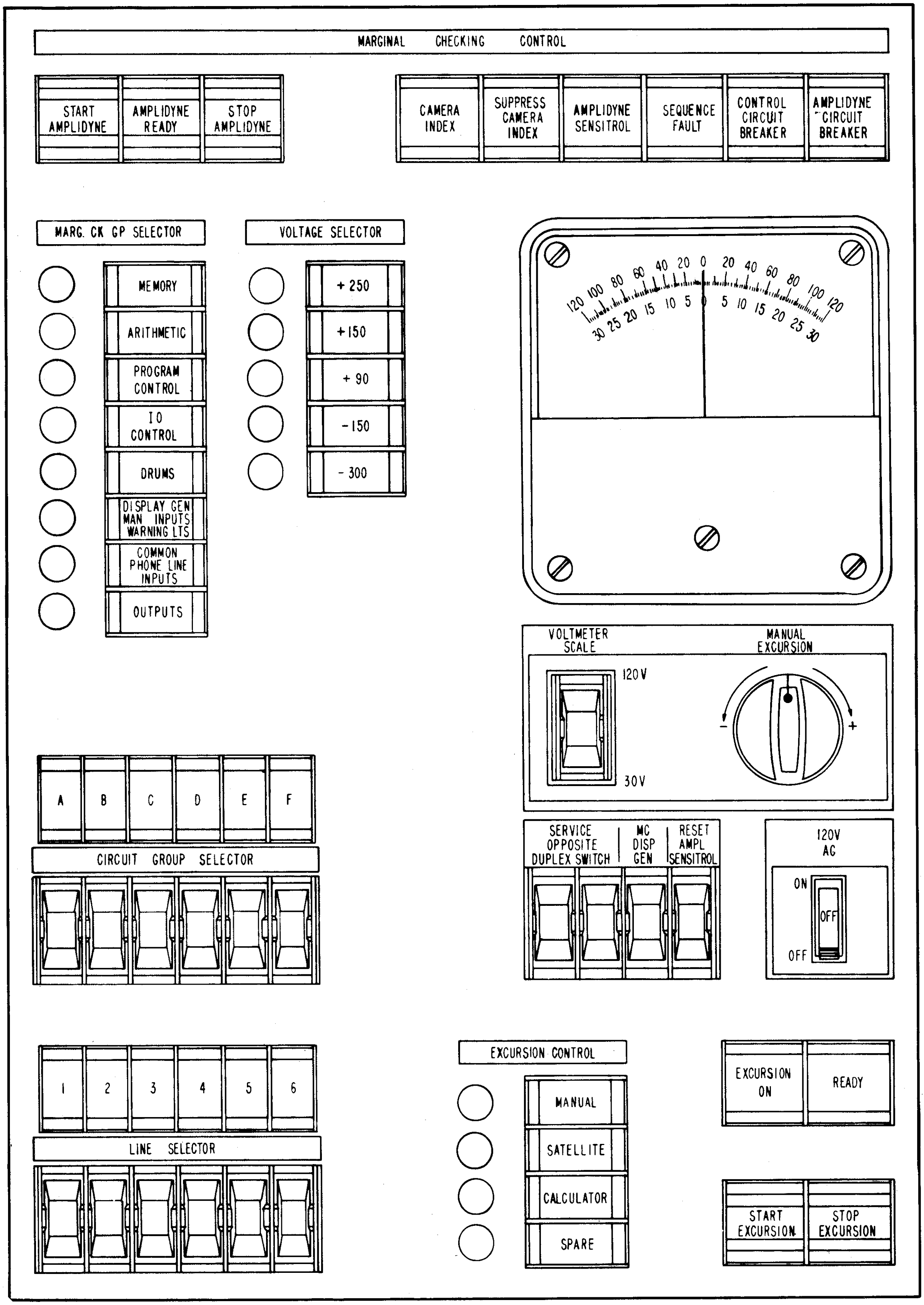


Figure 3–4. MC Control Panel, Module H, Duplex Maintenance Console

TABLE 3—3. DUPLEX MC CONTROL PANEL COMPONENTS

PANEL DESIGNATION	TYPE OF COMPONENT	FUNCTION
START AMPLIDYNE	Pushbutton	Starts the MC Amplidyne.
STOP AMPLIDYNE	Pushbutton	Stops the MC Amplidyne.
MARG CK GP SELECTOR	Interlocked pushbuttons (8)	Selects a particular equipment group to be connected to MC buses as determined by the voltage selector. Only one of the eight groups is selected at any one time. These pushbuttons are effective only in manual or satellite mode.
VOLTAGE SELECTOR	Interlocked pushbuttons (5)	Selects a particular voltage line to be marginally checked. Only one of the five voltages is selected at any one time. These pushbuttons are effective only in manual or satellite mode.
CIRCUIT GROUP SELECTOR	Lever switches (6)	Selects a particular circuit group to be marginally checked. These switches are effective only in manual or satellite mode. Since they are not interlocked, any combination of switches may be selected at one time. If no switches are selected, all circuits will be marginally checked.
LINE SELECTOR	Lever switches (6)	Selects a particular line within a circuit group to be marginally checked. These switches are effective only in manual or satellite mode. Since they are not interlocked any combination of switches may be selected at one time. If no switches are selected, all line groups will be marginally checked.
MODE SELECT	Interlocked pushbuttons (4)	Selects type of excursion and selection control to be used for marginal checking: MANUAL SATELLITE, or CALCULATOR. Each pushbutton is interlocked so that only one may be in selected position at one time. The fourth pushbutton is a spare. Some sites are not equipped with satellite control.
START EXCURSION	Pushbutton	Initiates an excursion sequence in manual or satellite mode. This pushbutton is inoperative in calculator mode.
STOP EXCURSION	Pushbutton	Removes any selection and excursion on the MC system. This pushbutton is operative in all modes.
MANUAL EXCURSION	Potentiometer	Used to control output of M C amplidyne. This control is operative in the manual mode only.
EXCURSION VOLTMETER	Voltmeter	Connected across output of MC amplidyne it measures excursion voltage applied to the circuit being checked.
VOLTMETER SCALE	Lever switch	A momentary-action lever switch used to select the multiplier on the excursion voltmeter. Normally, the scale is $\pm$20V; with this switch operated, the scale is $\pm$30V.
RESET AMPLIDYNE SENSITROL	Lever switch	A momentary action lever switch used to reset the amplidyne output voltage monitor.
MC CONTROL TEST	Lever switch	Permits the operation of the MC system to be tested without energizing the MC relays.

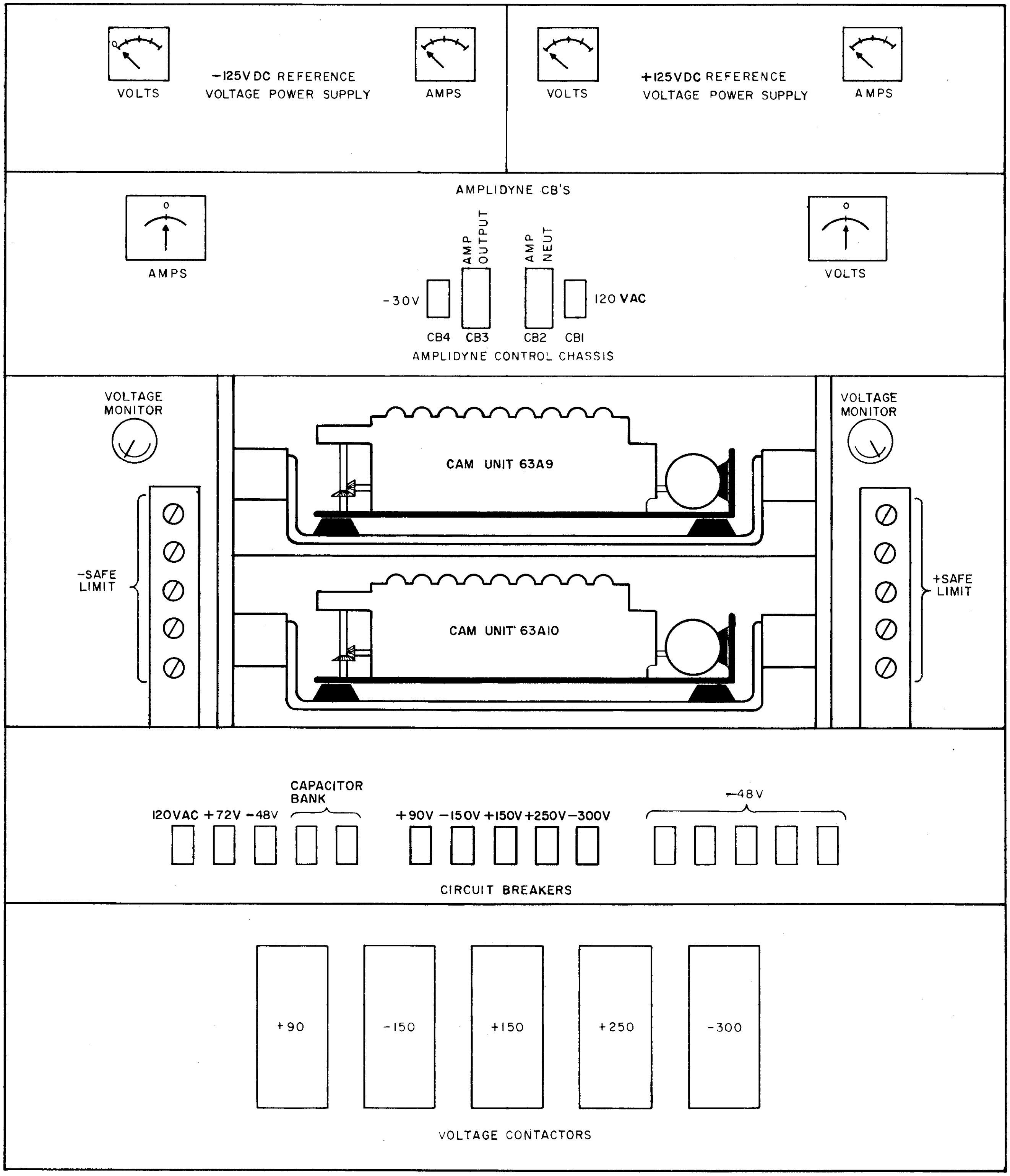


Figure 3–5. Controls and Indications, Module A, PCD Unit 63

TABLE 3–3. DUPLEX MC CONTROL PANEL COMPONENTS (cont'd)

PANEL DESIGNATION	TYPE OF COMPONENT	FUNCTION
MARG. CK GROUP SELECTOR	Lights	Indicates which MC group has been selected for an excursion. The indicator lights after the excursion starts.
VOLTAGE SELECTOR	Lights	Indicates which voltage has been selected for an excursion. The indicator lights after the excursion starts.
CIRCUIT GROUP SELECTOR	Lights	Indicates which circuit groups have been selected for an excursion. The indicators light after excursion starts.
LINE GROUP SELECTOR	Lights	Indicates which line groups have been selected for an excursion. The indicators light after the excursion starts.
MODE SELECT	Lights	Indicates which selection and excursion controls are operative: MANUAL, SATELLITE, or CALCULATOR.
EXCURSION ON	Light	Indicates that an excursion has been applied to the selected line or lines.
READY	Light	Indicates that the amplidyne is running and is ready but that no MC selection has been made.
AMPLIDYNE READY	Light	Indicates that the amplidyne is running and the amplidyne control circuits operating.
CONTROL CIRCUIT BREAKER	Light	Indicates that —48V and +72V control CB's in MC unit are closed.
SEQUENCE FAULT	Alarm light	Indicates a fault in the excursion on sequence of the MC system. A sequence fault automatically causes an excursion stop cycle.
AMPLIDYNE SENSITROL	Alarm light	Indicates that the amplidyne output has exceeded the safe limit.
AMPLIDYNE CIRCUIT BREAKER	Alarm light	Indicates an open CB in the amplidyne output circuit.
MC CONTROL TEST	Light	Indicates that the MC system is in test status. No excursion voltage can be applied to the computer, but all other MC operations can be performed.

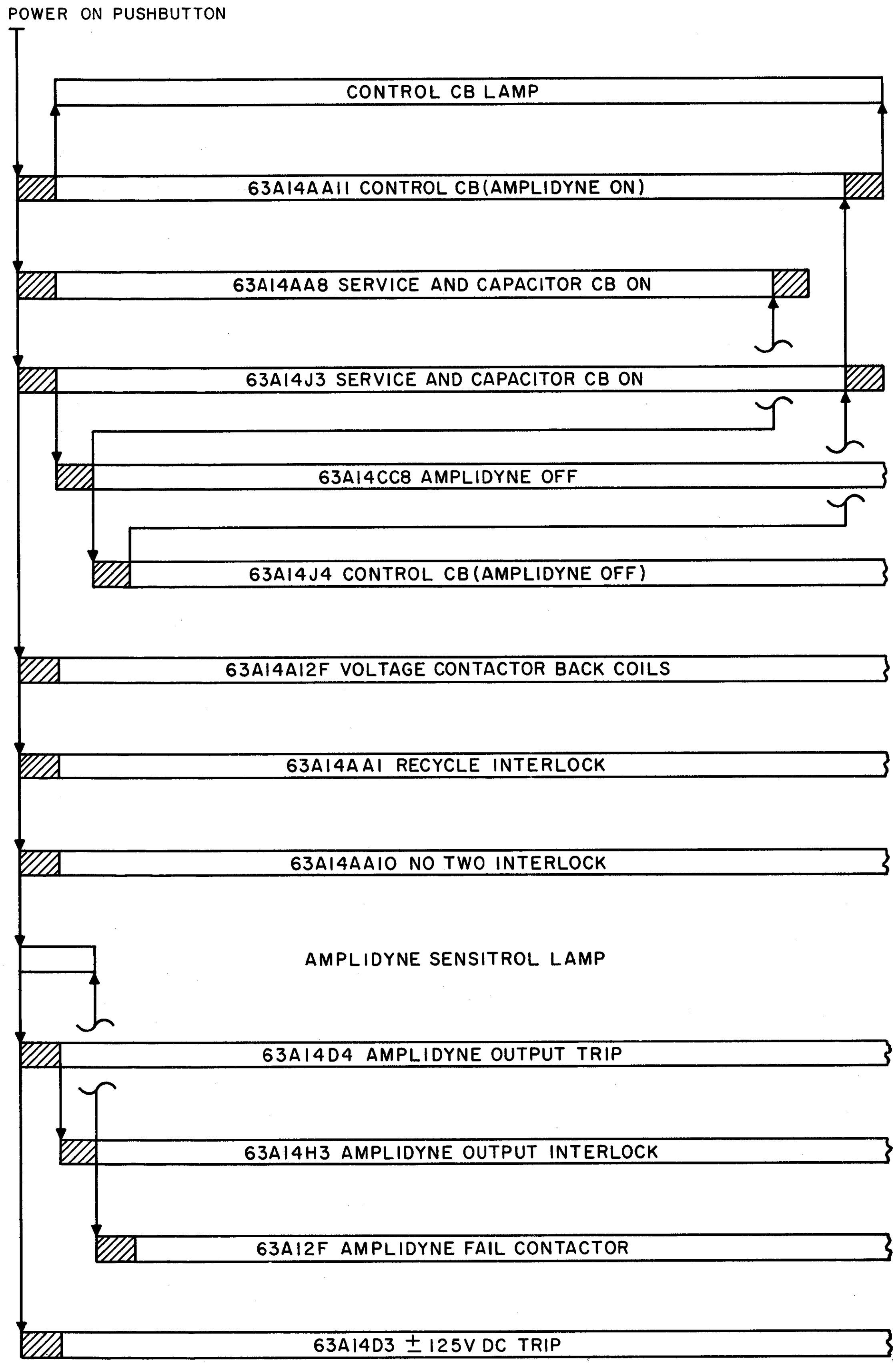


Figure 3-6. Duplex Power-On Sequence, Simplified Sequence Chart

SECTION 2
SEQUENCES TO PREPARE THE DUPLEX MC SYSTEM FOR OPERATION

2.1 INTRODUCTION

The duplex MC system is ready for operation when power is available, and the amplidyne and its associated circuits are operating. These conditions result from the following control sequences:

a. Power-on sequence

b. Start amplidyne sequence

2.2 POWER-ON SEQUENCE

Power is available to the MC system when power is applied to the computer equipment. The duplex power-on sequence is described in Part 3, Chapter 3, Section 2, *Theory of Operation, Power Supply System for AN/FSQ-7 and -8,* 3-82-0. Completing the power-on sequence and closing the CB's at the PCD unit and the MCD units energizes the interlock and control circuits that place the MC system in the power-on status. In this status the MC system can be controlled from the duplex maintenance console (fig. 3–6).

2.2.1 Service-Voltage and Capacitor-CB Interlock Circuits

The service-voltage and capacitor-CB interlock circuits ensure that each of the service-voltage CB's in the PCD unit are closed and that the regulating capacitors are connected to the amplidyne output circuit.

When power is applied (5.5.1.1, sect. 8) and all CB's are closed, —48Vdc is applied to service- and capacitor-on relays 63A14J3 and 63A14AA8. Relay 63A14J3 is energized through auxiliary contacts of CB 6 (amplidyne control CB), CB19 (amplidyne motor CB), microswitch contacts b-d of capacitor and service-voltage CB's 63A11A6 through 63A11A12, and normally closed contacts 2a-2b of relay 63A14J4. Relay 63A14AA8 is energized through the same path except that the pick path is through normally closed contacts 3a-3b of 63A14CC8 instead of contacts of 63A14J4.

Although both 63A14AA8 and 63A14J3 are energized, only the latter relay functions in the power-on sequence. Contacts 1a-1c of this relay are in the energizing circuit of amplidyne-off relay 63A14CC8, and contacts 5a-5c are in the energizing circuit of test relay 63A14DD24.

2.2.2 Control CB Interlock Circuit

The control CB interlock circuit functions during the power-on sequence to sense that the CB's supplying the MC-system control voltages are closed. If all these CB's are closed, control CB (amplidyne-on) relay 63A-14AA11 is energized when power is applied.

Amplidyne-off relay 63A14CC8 is energized through contacts 1a-1c of relay 63A14J3 (5.5.1.1, sect. 5), and held energized by its own contacts 1a-1c. When 63A14CC8 is energized, its contacts 3a-3b open and drop relay 63A14AA8 (5.5.1.1, sect. 8). Contacts 2a-2c of relay 63A14CC8 close to energize control CB (amplidyne off) relay 63A14J4. This relay will not be energized unless the MC control voltage CB's are closed. When relay 63A14J4 energizes, its contacts perform the following functions:

a. De-energize control CB (amplidyne on) relay 63A14AA11 by opening normally closed contacts 5a-5c (5.5.1.1, sect. 7)

b. De-energize the service and capacitor CB on relays 63A14J3 by opening normally closed contacts 2a-2b.

c. Connect the —48Vdc to the control panel switches through contacts 3a-3c (5.5.1.1, sect. 7).

2.2.3 MC Voltage Contactors

The MC voltage contactors are automatically reset when relay 63A14A12F is energized. Resetting ensures that the amplidyne output is not applied to a load unit through a sticking voltage contactor before the MC test is begun (5.5.10.1). When power is applied, —48Vdc energizes the back coils of the voltage contactors through normally closed contacts of the voltage selection relays.

2.2.4 Recycle Interlock

The recycle interlock is actuated to permit control of the amplidyne and the MC system from the maintenance console. When power is applied, the —48Vdc energizes recycle interlock relay 63A14AA1 through normally closed contacts a-b of both the START EXCURSION and STOP EXCURSION pushbuttons at the maintenance console (5.5.1.1, sect. 4).

When relay 63A14AA1 picks, the following actions occur:

a. A hold circuit is provided for the relay (5.5.1.1, sect. 5) through contacts 1a-1c.

b. Contacts 2a-2c close to condition the pick circuit of cam-start relay 63A14AA2 so that relay will pick when a start-excursion signal is applied (5.5.1.1, sect. 4).

c. Contacts 3a-3c close to condition the circuit to initiate automatic stop-excursion sequence if abnormal conditions occur (5.5.1.1, sect. 3).
d. Contacts 4a-4c close to condition the stop-excursion circuit to initiate a manual stop-excursion sequence when the STOP EXCURSION pushbutton is depressed (5.5.1.1, sect. 4).
e. The stop-excursion relay is interlocked so that a second stop cycle cannot start if the STOP EXCURSION pushbutton is held depressed (5.5.1.1, sect. 4).

2.2.5 No-Two Interlock

The no-two interlock circuit prevents an excursion from being initiated if more than one mode, equipment group, or voltage is selected. This circuit is energized and no-two interlock relay 63A14AA10 is energized when power is applied (5.5.1.3), and remains energized during MC operations. If a faulty selection is made, the interlock action will drop relay 63A14AA10 and cause the SEQUENCE FAULT indicator to light.

2.2.6 Amplidyne Relays

Relays 63A14D4 (amplidyne output trip), 63A14H3 (amplidyne output interlock), and 63A12F (amplidyne fail contactor) are energized during the power-on sequence. These relays function in the start-amplidyne sequence, and are discussed in paragraph 2.3.8.

2.3 START-AMPLIDYNE SEQUENCE

The TEST-OPERATE switch on module G of the maintenance console must be placed in the TEST position before the START AMPLIDYNE pushbutton is depressed. This action energizes relay 1G2(K4) and closes contacts 4a-4c of this relay (5.5.1.1, sect. 7).

The start-amplidyne sequence begins when the START AMPLIDYNE pushbutton is depressed after power has been applied and the TEST-OPERATE switch is in the TEST position. The sequence is complete when the amplidyne motor and the cam motors are running, the reference voltage power supplies and the field control chassis are functioning, and the various interlock and indicating circuits are activated to permit initiation of a start-excursion sequence (fig. 3—7).

2.3.1 Amplidyne-On Relays

The amplidyne-on relays 63A14D6 and 63A14AA6 control the following:

a. The magnetic motor starter (MMS) of the amplidyne motor
b. The cam motors of the cam timing units
c. The circuits associated with the amplidyne.

The amplidyne-on relays are energized when the START AMPLIDYNE pushbutton is depressed (5.5.1.1, sect. 7).

When the START AMPLIDYNE pushbutton is depressed, —48Vdc is applied to the amplidyne-on relays 63A14D6 and 63A14AA6 through contacts 2a-2b of the STOP AMPLIDYNE pushbutton, contacts 4a-4c of the computer test relay 1G2(K4), contacts 2a-2c of the START AMPLIDYNE pushbutton, and contacts 1a-1c of the amplidyne output interlock relay 63A14H3.

When the amplidyne-on relays pick, the following occur:

a. The MMS is energized through contacts 10-11 of 63A14D6, and the amplidyne motor starts (5.5.1.1, sect. 9).
b. The 120Vac circuit is completed to the warmup timer, the cam motors, and the reference voltage power supply through contacts 7-8 of 63A14D6 (5.5.2.3).
c. The service-and-capacitor-CB interlock circuit is energized by dropping control CB amplidyne-off relay 63A14J4. This relay is dropped when contacts 12-13 of relay 63A14D6 open (5.5.1.1, sect. 8).
d. The control CB amplidyne-on relay 63A14AA11, is energized through normally closed contacts 5a-5c of 63A14J4 and the microswitch contacts of the control-voltage CB's.
e. The stop-excursion circuit is conditioned by contacts 3a-3c of 63A14AA6 to initiate a stop-excursion sequence under abnormal conditions (5.5.1.1, sect. 3).
f. Contacts 4a-4c of 63A14AA6 prevent the amplidyne control-voltage monitor from being reset while the amplidyne is running (5.5.9.1, sect. 2).

2.3.2 Amplidyne Motor and Magnetic Motor Starter

The MMS starts the amplidyne motor and provides overload protection while the motor is running. The MMS is energized through contacts 10-11 of relay 63A14D6 when the START AMPLIDYNE pushbutton is depressed (5.5.1.1, sect. 9). When its coil is energized the MMS performs the following functions:

a. The AUX 1 contacts close to conditions the energizing circuits of field control relay 63A7-(K1) so that the relay will be energized when the warmup timer operates (par. 2.3.5).
b. The AUX 2 contacts short out the portion of the pick coil of the MMS that is not needed to hold the starter energized (5.5.1.1, sect. 9).
c. Contacts OL1 and OL3 open the circuit and drop the MMS if an overload condition is detected in the amplidyne motor (5.5.1.1, sect. 9). These contacts are operated by thermal overload coils in the 120Vac circuit of the amplidyne motor (5.3.2.1).

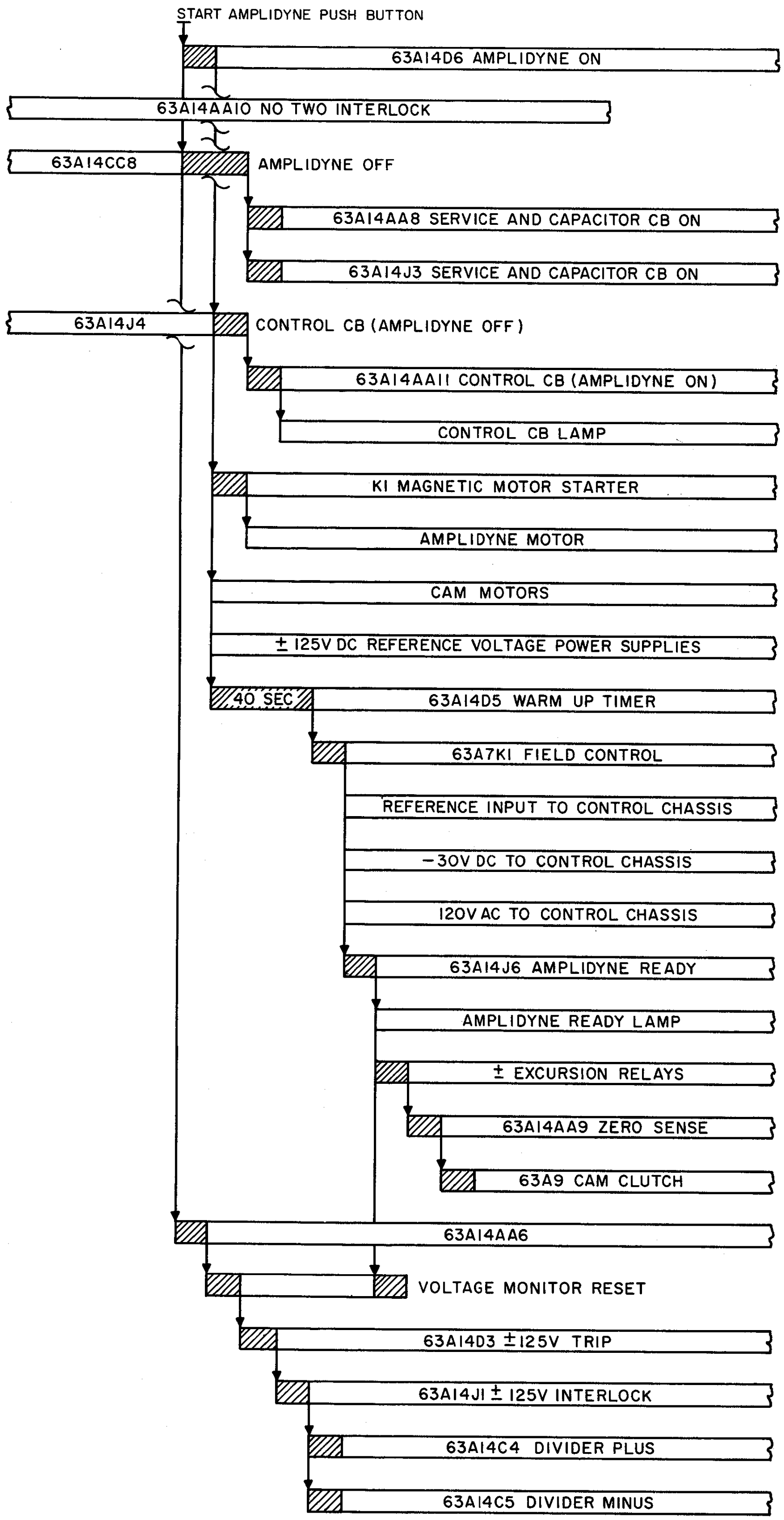


Figure 3–7. Duplex Start-Amplidyne Sequence, Simplified Sequence Chart

d. Contacts L3, L2, and L1 of the MMS (5.3.2.1, sect. 7) connect the three phases of unregulated 120Vac to the amplidyne motor.

2.3.3 Cam Motors

The cam motors are started during the start-amplidyne sequence when contacts 4-5 and 7-8 of relay 63A14D6 close to connect the regulated 120Vac circuit to the motors. The cam units are not coupled to the cam motors until an excursion sequence is initiated.

2.3.4 Reference Voltage Power Supplies

The reference voltage power supplies are energized through contacts 4-5 and 7-8 of relay 63A14D6 (5.5.2.3). The reference voltage power supplies are given 40 seconds to warm up before the output voltage monitors are activated. The moving contacts of the voltage monitors are held in the central position by the reset coils. These coils are de-energized when the amplidyne-ready relay 63A14J6 (5.5.1.1, sect. 9) is energized. Relay 63A14J6 is picked at the expiration of warmup timer.

2.3.5 Field-Control Relay

The field-control relay controls the inputs to the field-control chassis. Field-control relay 63A7(K1) is energized 40 seconds after the MMS is energized. This delay permits the amplidyne motor to come up the speed, and the reference voltage power supplies to stabilize before the field-control chassis begins to function.

When contacts 4-7 of the warmup timer close (40 seconds after the MMS is energized), —48Vdc is applied to field-control relay 63A7(K1) through contacts 1-3 of AUX 1 of the MMS (5.5.1.1, sect. 9); the warmup-timer contacts; and auxiliary contacts of —30Vdc CB 63A7(CB4), amplidyne output CB63A7(CB3), amplidyne neutral CB 63A7(CB2), and 120Vac CB 63A4 (CB1).

When relay 63A7(K1) is energized, the following actions occur:

a. Contacts 4a-4c close to connect the reference voltage power supply input to the field-control chassis (5.5.9.1, sect. 10)

b. Contacts 5a-5c close to connect the —30Vdc bias source to the field-control chassis (5.5.9.1, sect. 10).

c. Contact 1c closes to connect the regulated 126Vdc to the control chassis (5.5.9.1, sect. 10).

d. Contacts 6a-6c close to complete the circuit to amplidyne-ready relay 63A14J6 (5.5.1.1, sect. 9).

2.3.6 Zero-Sense Relay

Zero-sense relay 63A14AA9 conditions the cam-start and cam-stop circuits. The zero-sense relay is energized by contacts 1a-1c of minus-excursion relay 63A5-(K2) and plus-excursion relay 63A5(K1). Since either 63A5(K1) or 63A5(K2) is de-energized when the amplidyne output is greater than ±0.75V, the zero-sense relay is energized only when the amplidyne output is less than ±0.75V (par. 1.4, Part 2).

When relay 63A14AA9 is energized, contacts 1a-1c close to condition the —48Vdc circuit to the cam clutch relay 63A9 (5.5.1.1, sect. 5).

2.3.7 Plus- and Minus-Divider Relays

The plus- and minus-divider relays remove the reference input voltage from the amplidyne if there is an open circuit in the reference input voltage-divider network.

When ±125V interlock relay 63A14J1 (5.5.8.1, sect. 7) is energized through contacts 5-7 of relay 63A14D3, its contacts 5a-5c close to energize divider-plus relay 63A14C4, and its contacts 6a-6c close to energize divider-minus relay 63A14C5. Contacts 5-7 of each divider relay close to condition the pick circuit of reference input relay 63A14J2.

2.3.8 Amplidyne Output Interlock

The amplidyne output interlock ensures that the amplidyne is not supplying an abnormal output voltage. When power is applied, —48Vdc energizes amplidyne output trip relay 63A14D4. If the amplidyne output voltage is within limits (or with no excursion applied) the movable arm of the amplidyne output voltage monitor will not make contact, and relay 63A14D4 will remain energized. Assuming that the amplidyne output is normal, contacts 5-7 of relay 63A14D4 will complete the pick circuit to amplidyne output interlock relay 63A-14H3. When relay 64A14H3 is energized, the following actions occur:

a. The circuit to amplidyne-fail contactor 63A12F (5.5.9.1, sect. 2) is completed through contacts 3a-3c.

b. Contacts 1a-1c close in the start-amplidyne circuit (5.5.1.1, sect. 7). This circuit is now ready for operation.

c. Contacts 3a-3b open to extinguish the AMPLIDYNE SENSITROL light (5.5.11.1).

When amplidyne fail contactor 63A12F is energized (fig. 3–6) the following actions occur:

a. Contacts 1a-1c close in the circuit which applies 120Vac to the field-control chassis and the zero-sense chassis (5.5.9.1, sect. 11).

b. The normally closed short circuit (contacts 2b-3b) across the amplidyne output is opened (5.5.9.1, sect. 6).

c. The regulating capacitors are connected to the output terminals of the amplidyne through contacts 4a-4c (5.5.9.1, sect. 6).

The relays used in the amplidyne interlock circuit are normally energized during MC operations. In case of amplidyne output failure, the interlock action results from dropping these relays.

2.3.9 Indicators

A start-amplidyne sequence results in the illumination of the following three indicators on the MC control panel (5.5.11.1):

a. CONTROL CIRCUIT BREAKER

b. AMPLIDYNE READY

c. READY

The CONTROL CIRCUIT BREAKER light is illuminated through contacts 3a-3c of relay 63A14J4, and contacts 1a-1c of relay 63A14AA11. This light will remain illuminated unless a CB opens during the MC process. The AMPLIDYNE READY light is illuminated through contacts 3a-3c of the relay 63A14J4, contacts 3a-3c of relay 63A14J6, and contacts 4a-4c of relay 63A14AA8. The READY lamp is illuminated through contacts 3a-3c of relay 63A14J4, contacts 3a-3c of relay 63A14J6, normally closed contacts 3a-3b of excursion-on-delay relay 63A14AA5, contacts 5a-5c of relay 63A-14AA8, contacts 2a-2c of relay 63A14J1, contact 4 of relay 63A14AA1, and contacts 4a-4c of relay 63A14-AA10. This light will remain illuminated until one of the above relays is de-energized or an excursion is initiated. When an excurson is initiated, the excursion-on-delay relay is energized, its contacts 3a-3b open and the READY light is extinguished.

SECTION 3
DUPLEX CALCULATOR MODE EXCURSION SEQUENCES

3.1 INTRODUCTION

This section discusses the circuits employed in the selection, application and control of an excursion during calculator-mode operations. An excursion sequence consists of the following functions:

a. Starting the excursion
b. Selecting the equipment to be tested
c. Controlling the amplidyne to obtain an excursion voltage and applying this excursion voltage to the selected equipment
d. Allowing the selected circuits to perform their normal functions with an excursion applied
e. Returning the voltage on the line to normal when the excursion is completed
f. Disengaging the MC system from the selected equipment
g. Establishing conditions that allow another excursion to be started.

In the discussion of the various calculator-mode sequences, it is assumed that: (a) Power has been applied to the MC system and that the CONTROL CIRCUIT BREAKER lamp is lit to indicate that all control-and-service-voltage CB's are closed; (b) The amplidyne motor is running and the AMPLIDYNE READY lamp is lit to indicate that the amplidyne control circuits are operating properly; (c) The READY lamp is lit to indicate that the interlock circuits are engaged.

In calculator mode, an excursion is initiated and controlled by the circuits in the Central Computer. Depressing the CALCULATOR mode pushbutton on the duplex maintenance console conditions these circuits before the excursion is started.

When the CALCULATOR pushbutton is depressed, calculator mode relays 63A14C6 and 63A14J8 are energized through contacts 3a-3c of the pushbutton (5.5.5.1). Contacts of relay 63A14C6 perform the following functions (fig. 3–8, foldout).

a. Normally closed contacts 12-13 open to disconnect the START EXCURSION pushbutton from the energizing circuit of cam-start relay 63A-14AA2 (5.5.1.1). This action renders the pushbutton inoperative.
b. Contacts 4-5 close (5.5.4.1) to condition the instruction relays for operation by the relay drivers (RYD's) of the Central Computer.
c. Contacts 10-11 close to condition calculator mode relays 63A14Y23 and 63A14Y24. These relays are energized after the excursion cycle begins.

Contacts of relay 63A14J8 perform the following functions:

a. Contacts 5a-5c connect the voltage divider network to the reference input circuit (5.5.8.1, sect. 2).
b. Contacts 4a-4c and 2a-2c connect the 125V reference voltage to the safe-limit select circuit.

3.2 EXCURSION-START SEQUENCE

An excursion sequence is started when cam units 63A9 and 63A10 are coupled to the cam motors (fig. 3–8). Coupling occurs when the associated cam clutches are energized. The clutch of cam unit 63A9 is energized through contacts of cam 63A9 (C14), contacts 1a-1c of zero-sense relay 63A14AA9, and contacts 3a-3c of cam-start relay 63A14J5 (5.5.1.1, sect. 5). The zero-sense relay is energized during the start-amplidyne sequence (par. 2.3.6) and the cam contacts are closed at the cam-latch point of 245 degrees. Therefore, an excursion sequence will start when cam-start relay 63A14J5 is energized.

Cam-start relays 63A14AA2 and 63A14J5 are picked by relays under the control of programmed instructions from the Central Computer. The pick circuits for these relays are conditioned during the start-amplidyne sequence. The circuits are completed when start relays 63A14BB2 and 63A14BB3 are energized by *Operate* instructions from the Central Computer. Relay 63A14AA2 is energized through contacts 2a-2c of relay 63A14BB3 (energized by a 1 in the left-sign bit of the control word) and contacts 4a-4c of relay 63A14BB2 (energized by a *PER 21* instruction).

Note

The same *PER 21* instruction that energizes relay 63A14BB2 also conditions the RYD's in the test register to transfer the MC instructions and control data to the calculator control relays (0.1.3).

3.3 SELECTING EQUIPMENT FOR TESTING

The first process controlled by the cam contacts is the selection of the equipment to be marginally checked.

Since the status of the MC relays determines the type of voltage (MC or non-MC) supplied to the circuits, the selection process of the excursion sequence must result in energizing those MC relays which will distribute an MC voltage to the portion of the equipment to be tested. The selection circuit is completed through the contacts of line-group, circuit-group, MCD-isolation, and intermediate relays. The relays which complete the selection circuit are energized by the output of the calculator-selection matrix.

3.3.1 Equipment-Group Selection

The equipment-group selection limits the application of an excursion to a specific area of the equipment. The distribution system allows the equipment-group selections to be made, in general, according to the units supplied by an individual MCD unit. Equipment groups 1 through 4 are supplied through MCD unit 19. Equipment groups 5, 6, 7, and 8 are supplied through MCD units 29, 27, 59, and 31, respectively.

3.3.1.1 Selection Circuit

The relays which limit the MC test to the selected equipment group are picked when cam C1 of cam unit 63A9 closes its contacts to complete the circuit conditioned by the group-selector relays (5.5.3.3).

When the calculator mode is selected, contacts 2a-2c of relay 63A14Y23 close. The MC-group selection is now determined by the calculator-control relays assigned to equipment-group selection. A calculator-controlled relay is energized if the associated RYD in the Central Computer is conditioned by a 1 in the corresponding bit position of the MC word in the test register (5.5.4.1). Relays 63A14BB19 through 63A14BB22 are controlled by bits RS through R3, respectively, of the MC word. The bit configuration of this group of bits determines the equipment group selected. For example, if only bit R3 contains a 1, (the bit configuration to select MC group 1) only relay 63A14BB22 will be energized through points 4-5 of calculator-mode relay 63A14C6 (b, par. 3.1). When relay 63A14BB22 is energized, a path through the relay matrix is established by normally closed contacts 1a-1b of relays 63A14BB19, 63A14BB20, 63A14BB21, and now closed contacts 1a-1c of relay 63A14BB2. The output of the matrix energizes relays 63A14CC9, 63A14CC10, and 63A14Y1.

3.3.1.2 Function of MC Equipment-Group Relays

Two sets of relays, the MC group relays and the MC isolation relays, are used to isolate the selected group of equipment. The MC group relays perform the following functions (MEMORY is a typical selection):

a. Light the appropriate selection light on the control panel at the maintenance console (5.5.11.1). For an MC group 1 (MEMORY) selection, the MEMORY light is illuminated through contacts 2a-2c of relay 63A14CC9

b. Condition the various matrix circuits which develop the final selection of the equipment to be tested (5.5.13.1). The MEMORY selection conditions the voltage-selection matrix through points of relay 63A14Y1

c. Condition a matrix circuit for selection of the proper safe-limit relay (5.5.6.1). The MEMORY selection conditions the safe-limit circuits through points of relay 63A14CC9

d. Condition the no-two interlock circuit (5.5.1.3, sect. 8). The MEMORY selection conditions this circuit through contacts 1a-1c of relay 63A14-CC10

e. Condition the energizing circuit of voltage and MC-selected relay 63A14AA12 through contacts 2a-2c of relay 63A14CC10

The MCD isolation relays for MCD unit 19 do not pick until cam 63A9(C1) is rotated 20 degrees. This delay is required because MCD unit 19 services MC groups 1 through 4, and the isolation relays are picked through contacts of the MC group relays. The contacts of the MC group relays would be damaged if power were present when the contacts transferred.

3.3.2 Voltage-Group Selection

The voltage-group selection limits the application of the MC excursion to a specific voltage within the selected MC equipment group. The voltage-group selection is performed by the voltage relays and voltage contactors. The function of limiting the distribution of the MC voltage is performed by the voltage-selection circuit and contacts of the selected MC group relays.

3.3.2.1 Selection Circuit

The voltage relays are selected when cam 63A9(C3) closes its contacts at 20 degrees of cam rotation. A hold circuit for the selected voltage relay is provided by cam 63A9(C18) until 360 degrees of cam rotation (5.5.3.2).

When the calculator mode is selected, relay 63A14Y23 is energized and contacts 5a-5c of this relay condition the voltage-selection matrix. The voltage-selection relays 63A14BB16, 63A14BB17, and 63A14-BB18 are energized by the RYD's associated with bits L13 to L15, respectively, of the MC control word. If only bit L15 contains a 1 (typical +250V selection), relay 63A14BB18 will be energized (5.5.4.1). Contacts 1a-1c of this relay will complete the energizing circuit to +250V select relay 63A14AA13 (5.5.3.2).

3.3.2.2 Functions of the Selected Voltage Relays

When typical voltage-contactor relay 63A14AA13 is energized, contacts 5a-5c complete the circuit to the

transfer coil of +250V contactor 63A12B (5.5.10.1) and remove power from the back coil. Power is still applied to the back coils of the unselected voltage contactors to prevent them from energizing.

The voltage selection also combines with an equipment group selection to pick intermediate relays. When relay 63A14BB18 is energized, its contacts 1a-1c close to complete the circuit through contacts 1a-1c of relay 63A14Y1 to MCD unit 19 isolation relays 19A9A2 through 19A9G2. Contacts 3a-3c of the selected voltage relay 63A14AA13 close in the safe-limit select matrix (5.5.6.1).

3.3.3 Circuit Group Selection

The circuit-group-selection relays are energized when cam 63A9(C13) closes its contacts at 40 degrees of cam rotation. A hold circuit is provided for the circuit-group-select relays through cam 63A9(C4) until 320 degrees of cam rotation (5.5.3.4). Any number of circuit selections may be made. The selections are specified by bits R4 through R9 of the MC control word.

3.3.3.1 Selection Circuit

When the calculator mode is selected, contacts 4a-4c of relay 63A14Y23 close to connect the circuit-selection-relay matrix to cam 63A9(C13). The circuit group selection is determined by relays 63A14AA19 through 63A14AA24, which are associated with bits R4 through R9, respectively, of the MC control word. Each relay controls a separate group of circuit-group relays (5.5.3.4). This arrangement is different from the arrangement used in selecting equipment and voltage groups. The matrix arrangement in equipment- and voltage-group selection prevents more than one selection at a time; the separate relay arrangement in circuit-group selection permits the selection of more than one circuit simultaneously.

Assuming that circuit group C is selected (a 1 in bit R6 of the control word), relay 63A14AA21 will be picked (5.5.4.1). Contacts 1a-1c of this relay close to complete the circuit to relays 63A14Z21, 63A14DD9, 63A14DD10, 63A14DD11, and 63A14DD12 (5.5.3.4).

3.3.3.2 Functions of Circuit-Group Relays

The contacts of the selected circuit relays condition the pick circuit of the MC relay. When ciruit-group C relay 63A14Z21 is energized, its contacts 4a-4c close in the pick path of the MC relay (5.5.7.2).

Contacts 3a-3c of relay 63A14DD9 close to connect the selected +250V line to the +0V safe limit. Contacts 3a-3c of relay 63A14CC10 close to connect the selected voltage to the —100V safe limit (5.5.6.1).

3.3.4 Line Group Selection

A line-group selection limits the application of a test voltage to a specific line within a circuit. The line-selection relays are energized when cam 63A9(C13) closes its contacts at 40 degrees of cam rotation (5.5.3.1). A hold circuit is provided for the line relays by cam 63A9(C4) until 320 degrees of cam rotation. Cams 63A9(C13) and 63A9(C4) are also used to energize the circuit-group relays.

The lines selected depend on the configuration of bits R10-R15 of the control word. Any number of line groups may be selected simultaneously; however, in calculator mode, a line selection must be indicated in order to select a line.

3.3.4.1 Selection Circuit

When the calculator mode is selected, contacts 3a-3c 63A14Y23 close to condition the line-group selection relays (5.5.3.1).

Calculator-controlled relays 63A14Z1 through 63A14Z6 are controlled by the RYD's associated with bits R10-R15 in the MC control word. Assuming that only bit R13 contains a 1 (line 4 selected), relay 63A14Z4 will be energized (5.5.4.1). When relay 63A14Z4 is energized, its contacts 1a-1c close to complete the energizing path to line-select relays 63A11Z10 and 63A14Z16.

3.3.4.2 Function of Line-Group Relays

The contacts of the line-group relays complete the pick circuit to the MC relays. The selection of line-group 4 completes the line-circuit selection within the MC equipment-group selection. The selection is complete when contacts 3a-3c of relay 63A14Z16 close the circuit to the MC relay (5.5.7.2). Contacts 3a-3c of relay 63A14Z10 close to complete the —100V safe-limit selection circuit (5.5.6.1).

3.3.5 Intercommunication Relays

The intercommunication relays permit the standby computer to check the circuits that normally communicate with the active computer. The circuit output must be tested during marginal checking to evaluate the circuit operation. The outputs of the intercommunication circuits would normally have to be tested by the active computer. Since this is not permissible, the intercommunication relays loop the circuit outputs back into the standby computer when intercommunication circuits are being marginally checked.

Intercommunication relays 1H3 (K9) and 1H3 (K10) are energized when circuit/line selections A-2, A-6, B-1, C-1, C-2, and D-1 are made in MC group 4 (5.5.1.1, sect. 2, and 5.5.7.16). The intercommunication relay coils and contacts are shown on Central Computer logic 0.7.5, zone 7E.

3.4 NO-TWO INTERLOCK CIRCUIT

The no-two interlock circuit prevents the selection of more than one mode of operation, one MC equipment group, or one voltage group. In calculator mode,

this interlock functions only to prevent selection of more than one mode of operation.

No-two interlock relay 63A14AA10, picked when power is applied to the MC system, is energized through closed contacts of the MCD isolation relay and the following normally closed contacts (5.5.1.3):

a. 3a-3b of manual-mode relay 63A14Y20

b. 4a-4b of satellite-mode relay 63A14Y21

c. 3a-3b of each of the voltage- and equipment-group relays

A hold circuit is provided by cam 63A9 (C12) and closed contacts 1a-1c of the no-two interlock relay. When the calculator mode is selected, the normal energizing path for the interlock relay is through only the normally closed points of the manual-mode and satellite-mode relays. If either of these modes is selected while calculator relay 63A14Y23 is energized, the circuit to the no-two interlock relay is broken, and the relay is de-energized. If the interlock relay drops, the SEQUENCE FAULT indicator lights and a stop-excursion sequence is initiated.

In calculator mode, this interlock does not operate to prevent the selection of more than one equipment group or voltage group because the bits of the MC control word are coded so that only one equipment group and one voltage group can be designated.

For the detailed operation of this interlock circuit, refer to Section 4.

3.5 EXCURSION CONTROL

An excursion is controlled by varying the current in the amplidyne field winding. Figure 3–9 is a simplified block diagram of the circuits used to control an excursion. The reference voltage power supplies are the sources of the amplidyne input. The reference voltage is applied across a voltage-divider network which limits the amplidyne output voltage to the safe limit of the circuit to be tested. In the calculator mode, the voltage divider network also selects the magnitude of the excursion voltage.

The field-control chassis receives the reference input voltage and controls the amplidyne to provide an output corresponding to the reference input.

The output voltage of the amplidyne is connected to the selected voltage line through the voltage contactor. The resulting voltage (line voltage plus amplidyne output voltage) is applied to the selected circuits in the equipment through the MC relays.

3.5.1 Reference Voltage Power Supply Output

The 125Vdc outputs from the reference voltage power supplies are connected to the voltage-divider network through contacts of relay 63A14J1. The +125Vdc output is connected through contacts 5a-5c of relay; the −125Vdc output is connected through contacts 6a-6c (5.5.8.1, sect. 6).

3.5.2 Reference Input Selection

The 125Vdc reference-input voltage is connected to the amplidyne control circuits through contacts 3a-3c of reference input relay 63A14J2 (5.5.8.1, sect. 1). Contacts 5a-5c of calculator-mode relay 63A14J8 connect the output of the selected voltage divider to the reference-input line.

The reference input voltage is applied to the amplidyne control circuit after the MC relays connect the MC voltage line to the load circuits. The following conditions must exist before the energizing circuit for reference-input relay 63A14J2 is completed (5.5.1.1, sect. 1):

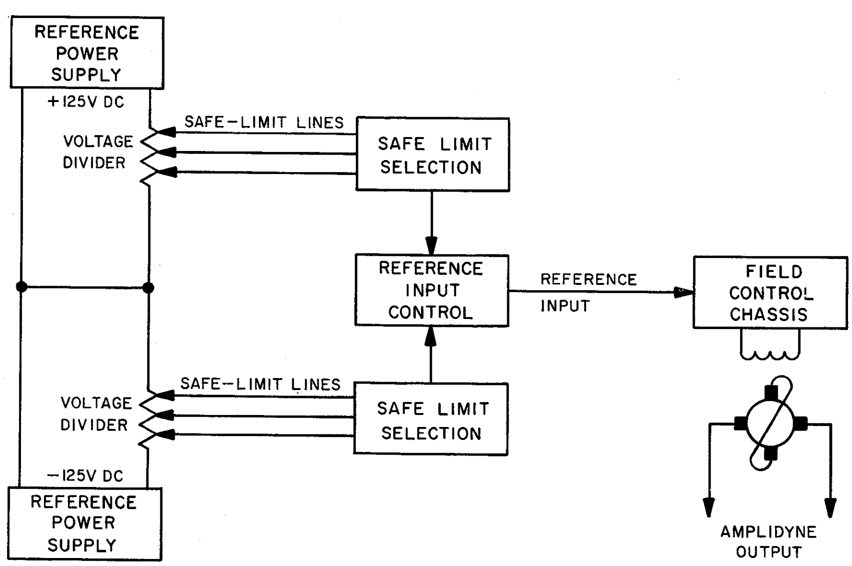


Figure 3–9. Excursion Control Circuits, Simplified Block Diagram

a. The output of each reference voltage power supply must be within 10 percent of the nominal 125Vdc. If the voltage is not within this limit, contacts 3a-3c of ±125V interlock relay 63A14J1 open the energizing circuit to relay 63A14J2 (par. 2.5.10.3, Part 2, Ch 1).

b. The MC control-voltage CB's must be closed. Control CB (amplidyne on) relay 63A14AA11 drops to open the energizing circuit to relay 63A14J2 if a CB is open (par. 2.2.2 and 2.3.1, Sect. 2).

c. The excursion sequence must be on and excursion-on relay 63A14AA4 must be energized.

d. The voltage-divider networks in the reference input control circuitry must be connected to the reference voltage power supplies as outputs. The divider relays (plus, minus, and calculator) drop if an open circuit occurs in the divider-relay interlock circuit (par. 2.5.10.2, Part 2, Ch 1). The energizing circuit to the reference input relay is opened if any one of the divider relays is de-energized.

e. The amplidyne output circuits must be functioning properly. Amplidyne output interlock relay 63A14H3 is energized unless an overvoltage condition is detected. If an overvoltage condition is detected, contacts 5a-5c of relay 63A14H3 open the energizing circuit to relay 63A14J2 (par. 2.5.10.4, Part 2, Ch 1).

If any of the above circuits fail to function properly, reference input relay 63A14J2 will be de-energized and its contacts 3a-3b will connect the reference input voltage circuit to amplidyne neutral.

3.5.3 Safe-Limit Selection

The safe-limit selection protects the circuits being tested from damage by excessive voltage. The safe-limit selection is made at the voltage-divider network in the reference input control circuitry.

3.5.3.1 Divider Network

The voltage applied to the divider network is determined by safe-limit selection relays 63A14K1 through 63A14K10 and 63A14J9 (5.5.8.1, sect. 5). These relays are energized through contacts of the safe-limit select matrix (5.5.6.1). The reference input voltage is applied to the divider network through the contacts of the safe-limit select relays and a potentiometer. The potentiometer drops the 125Vdc input to the level of the selected safe-limit.

3.5.3.2 Safe-Limit Selection Circuit

A maximum safe limit is assigned to each excursion voltage to prevent the MC test voltage from damaging the selected circuit. Safe limits of 0, 25, 50, 75, and 100 volts of either polarity may be selected.

The amount of voltage variation that a circuit will withstand before being damaged depends on the circuit type and circuit application. Similar circuits may withstand different voltage variations, depending upon the particular application of the circuit. Therefore, the selection of a safe limit for an excursion voltage is determined by the circuit-group/line-group selection within an MC equipment group and voltage group.

A safe-limit selection consists of energizing two safe-limit relays for each excursion. These relays establish the highest and the lowest excursion voltages than can be applied to the circuit.

Relay matrices determine which safe-limit relays are energized for a particular excursion. The matrices are made up of contacts of the MC equipment-group, voltage-group, and circuit-group relays (5.5.6.1). A voltage-group selection closes contacts to apply power to two relay matrices. One matrix completes a circuit to energize a relay representing the lower safe-limit voltage. The second matrix completes a circuit to energize a relay associated with the upper safe-limit voltage. In certain voltage-group selections, power is applied directly to the safe-limit relays without passing through a relay matrix. This arrangement is used when all the circuits serviced by a voltage have the same safe limit. For example, all of the circuits serviced by the +150Vdc line will withstand a —100V excursion. Therefore, the contacts of the +150Vdc voltage group relay directly energize the —100V safe-limit relay.

3.5.4 Excursion Polarity Control

The polarity of an excursion voltage is determined by the polarity of the reference voltage applied to the amplidyne field winding through the voltage-divider network. The polarity of the reference input voltage is determined by bit L7 in the MC control word. If bit L7 contains a 0, the polarity is positive. If bit L7 contains a 1, minus polarity relay 63A14BB10 is energized by the associated RYD through cam 63A10(C1) and contacts 7-8 of relay 63A14C6. When relay 63A14BB10 energizes, its contacts 1a-1c close in the pick path of minus-polarity relays 63A14H1 and 63A14H2. These relays are energized when cam 63A10 (C7) makes contact at 265 degrees of cam rotation. When relays 63A14H1 and 63A14H2 are energized, the following actions occur:

a. Contacts 4a-4c of 63A14H1 and 2a-2c of 63A14H2 connect the —125Vdc reference power supply to the safe-limit-select circuit (5.5.8.1, sect. 6).

b. Contacts 2a-2b of 63A14H1 open to disconnect the +125Vdc reference power supply from the safe-limit-select circuit (5.5.8.1, sect. 6).

c. Contacts 3a-3c of 63A14H1 connect amplidyne neutral to the reference input if a zero-volt safe-limit is selected (5.5.8.1, sect. 2).

d. Contacts 2a-2c, 3a-3c, 5a-5c, and 6a-6c of 63A14H2 complete the energizing circuit between the excursion relays and the negative safe-limit relays (5.5.8.2).

3.5.5 Excursion Magnitude Control

The excursion voltage varies with the reference input voltage to the amplidyne. The magnitude of the excursion voltage is controlled by bits in the MC control word.

In the calculator mode, the excursion voltage is determined by the point in the voltage divider selected as the output. There are 16 positive and 16 negative excursion voltages ranging from 0 to 100V.

The selection of an excursion voltage is controlled by bits L9 through L12 in the control word. The RYD's associated with these bits control relays 63A14BB11 through 63A14BB14. These relays are energized when calculator-mode relay 63A14C6 is energized (5.5.4.1 sect. 11). The contacts of the excursion-magnitude relays form a matrix which energizes the proper excursion relay (5.5.8.2). For example, if the configuration of bits L9 through L12 were 0100 ($\pm$16V excursion), only relay 63A14BB12 would be energized. Relay 63A14BB12 is energized through contacts 4a-4c of relay 63A14J6, cam 63A10(C1), and contacts 7-8 of relay 63A14C6. Relay 63A14BB12 energizes 16V-excursion relay 63A14F8. The energizing path for this relay is through cam 63A10(C7), normally closed contacts 1a-1b of relay 63A14BB11, now closed contacts 2a-2b of relay 63A14BB11, now closed contacts 1a-1c of relay 63A14BB12, normally closed contacts 2a-2b of relay 63A14BB13, and normally closed contacts 3a-3b of relay 63A14BB14 (5.5.8.2). When relay 63A14F8 energizes, its contacts 2a-2c close to connect the 16V tap of the voltage-divider network to the calculator mode reference-input-voltage line (5.5.8.1).

A second selection circuit provides for the selection of an excursion relay corresponding to the selected safe-limit voltage. This selection circuit ensures that no voltage larger than the selected safe limit is selected at the voltage divider. If an excursion voltage less than the safe-limit voltage is selected, the tap corresponding to the safe-limit selection is disconnected from the reference input lines when the excursion voltage relay is energized. If an excursion voltage greater than the safe-limit is selected, the greater excursion voltage is disconnected from the reference input lines by the transfer of the excursion relay corresponding to the safe-limit selection. Therefore, the excursion-voltage relay energized by the contacts of the safe-limit relay prevents a reference input voltage larger than the safe limit from being applied to the reference input line.

3.5.6 Applying The Excursion

The excursion voltage generated by the amplidyne is connected to the selected voltage line by the voltage contactors in the PCD unit. The MC test voltage is connected to the selected load circuits by the MC relays in the MCD units. The MC relays are transferred before the voltage is varied. This paragraph describes the application of the voltage through the voltage contactors and MC relays. The method of selecting the voltage contactors and MC relays is described in paragraphs 3.3.2 and 3.3.1, respectively.

3.5.6.1 Voltage Contactors

The voltage contactors connect the amplidyne output in series with the MC voltage from the power supply. In the de-energized state, the voltage contactors disconnect the amplidyne output from the load circuit and connect the MC voltages from the power supply unit directly to the contacts of the MC relays in the MCD units (5.3.2.1).

3.5.6.2 MC Relays

The contacts of the MC relays distribute all voltages to the circuits that may be selected for marginal checking. When the circuit serviced by a particular MC relay is not selected for marginal checking, the MC relay is de-energized and the contacts distribute non-MC voltages to the load units. The circuit-selection sequence energizes particular MC relays, and the MC-relay contacts transfer. Therefore, when a circuit is selected for marginal checking, the associated MC relay is energized and the contacts distribute the MC test voltage to the selected load unit.

3.5.7 Excursion Duration Control

The duration of an excursion must be long enough to permit the circuits to perform normal operations while the abnormal voltage is applied. In the calculator mode, an excursion may be 3, 7, or 30 seconds, or infinite in duration. Electromechanical timing relays control the excursion duration. Each timer consists of three cam-control assemblies and a motor. The contacts of the relay are opened and closed by the cams. The motor is actuated at the beginning of an excursion. After a preset time delay, the cams have rotated to close the contacts which complete a stop-excursion circuit.

Two of the three cam assemblies in each timer close contacts in the stop-excursion circuit. The third assembly closes contacts in the circuit that resets the timer. The two contacts used in the stop-excursion circuit are set to operate at different time intervals. The use of two electromechanical relays therefore provides for four excursion durations. However, the duration-selection circuit provides for the use of only the three

finite time durations. The 3- and 7-second excursions are provided by timer 63A14C1; the 30-second excursion is provided by timer 63A14C2.

The duration of the excursion is determined by bits L5 and L6 in the MC control word. The RYD's associated with these bits energize relays 63A14BB8 and 63A14BB9 when calculator-mode relay 63A14C6 is energized (5.5.4.1, sect. 11). The contacts of the excursion-duration relays form a matrix which selects the proper timer-control assembly (5.5.1.2). For example, assume that only bit L6 contains a 1 (3-sec duration). Relay 63A14BB9 is energized through contacts 7-8 of relay 63A14C6 and cam 63A19(C1). A hold circuit is completed through cam 63A9(C7) and contacts 1a-1c of relay 63A14BB9. The energizing circuit for duration relay 63A14G3 is now conditioned by normally opened contacts 4a-4b of relay 63A14BB8, and now closed contacts 5a-5c of relay 63A14BB9. Relay 63A14G3 will energize when cam 63A10(C5) rotates to 290 degrees and start-excursion relay 63A14BB2 is energized.

The excursion-duration timers are energized through closed contacts 3a-3c and 5a-5c of duration relay 63A14G3 (5.5.2.3). Both excursion-duration timers are energized, but only the points which correspond to the desired duration stop the excursion.

If neither bits L5 nor L6 contains a 1, neither excursion-duration relay is energized, relay 63A14G3 remains de-energized, the excursion-duration timers are not activated, and the excursion continues indefinitely.

An excursion-stop sequence is initiated when contacts of the duration timer close to pick excursion-duration-stop relay 63A14CC7 (5.5.1.2). If bit L5 contains a 0 and L6 contains a 1, the duration-stop relay will be energized through normally closed contacts 2a-2b of relay 63A14BB8, closed contacts 2a-2c of relay 63A14BB9, contacts 2a-2c of timer 63A14C1, and normally closed contacts 2a-2b of simplex relay 63A14CC3.

Note

Contacts 2a-2c of timer 63A14C1 close after 3 seconds. If a 7-second duration were selected, contacts 2a-2c of relay 63A14BB8 would be closed and the energizing path for 63A14CC7 would be across the 7-second contacts 1a-1c of timer 63A14C1(5.5.1.2). A similar energizing path for a 30-second duration requires relays 63A14BB8, 63A14BB9, and timer 63A14C2 to operate.

3.5.8 Duration Stop

A duration-stop sequence is initiated when contacts of the excursion-duration timer close to complete the energizing circuit to duration-stop relay 63A14CC7 (5.5.1.2). The contacts of this relay perform the following functions:

a. Contacts 5a-5c close to energize excursion-stop relay 63A14AA3 (5.5.1.1, sect. 3).
b. Contacts 2a-2c close to complete the energizing circuit to cam-clutch relay 63A10 through cam 63A10(C8). This action permits cam 63A10 to function during the excursion-stop sequence (5.5.1.2, sect. 4).
c. Contacts 1a-1c close to provide a hold circuit for the duration-stop relay (5.5.1.2, sect. 3).
d. Contacts 3a-3c close to condition the restart circuits (5.5.1.2, sect. 1).

3.6 CHANGE-EXCURSION SEQUENCE

A change-excursion sequence affects the only magnitude, polarity, or duration of the excursion voltage; it does not affect the equipment previously selected by a start-excursion sequence. A change-excursion sequence is initiated by an MC test word with a 0 in the left-sign bit. When an *Operate 21* instruction is given and the left-sign bit of the MC word is 0, the following actions occur:

a. A hold circuit is established for the relays which select the equipment to be tested.
b. The relays which control the magnitude, duration, and polarity of the excursion are de-energized and other magnitude, duration, and polarity relays are selected as indicated in the MC control word.

An *Operate 21* instruction from the Central Computer energizes *PER 21* relay 63A14BB2 (5.5.4.1, sect. 1). If the left-sign bit is 0, then the associated RYD and relay 63A14BB3 are not energized. Contacts of relays 63A14BB2 and 63A14BB3 perform the following functions:

a. Prevent a full excursion sequence by maintaining open contacts 2a-2b of relay 63A14AA3 in the energizing path of cam-start relays 63A14J5 and 63A14AA2 for cam unit 63A9 (5.5.1.1, sect. 4).
b. Maintain a hold circuit for the MC selection relays through the contacts of cam 63A9(C19) which are closed at the latch point of cam unit 63A9 (5.5.4.1).
c. Rotate cam unit 63A10 by picking cam-clutch relay 63A10 through normally closed contacts 1a-1b of excursion start relay 63A14BB3 (5.5.1.2, sect. 4).
d. De-energize the relays that control the selection of an excursion and reselect excursion relays according to the new MC word (5.5.4.1). This action is accomplished by rotating cam unit 63A10.

When cam unit 63A10 is rotated, a new excursion voltage is applied to the same load-unit circuits that were selected by the preceding MC word (par. 3.5).

3.7 STOP-EXCURSION SEQUENCE

A stop-excursion sequence returns the excursion voltage to zero and deselects the equipment that has been marginally checked (fig. 3—10, foldout). The excursion voltage is returned to zero by connecting the amplidyne reference input to amplidyne neutral. The deselection process is accomplished by rotating both the cam units to open the hold circuits for the selection relays.

For purposes of explanation, it will be assumed that calculator-controlled tests have been completed on MC group 1, +250 voltage group, circuit group C, and line 4, and that this selection had a —16V excursion. This selection is essentially the same as that discussed in paragraphs 3.4 and 3.5.

In the calculator mode, the stop-excursion sequence is initiated by energizing stop-excursion relay 63A14AA3 (5.5.1.1 sect. 3).

3.7.1 Initiating the Stop-Excursion Sequence

In calculator mode, a stop-excursion sequence is normally initiated by a *Stop Excursion (PER 22)* instruction from the Central Computer. This instruction energizes stop-excursion relay 63A14BB1. Contacts 5a-5c of relay 63A14BB1 complete the circuit to relay 63A14AA3 (5.5.1.1, sect. 3). The various circuits affected by the contacts of relay 63A14AA3 are discussed in the following paragraphs.

3.7.2 Returning the Excursion Voltage to Zero

Energizing relay 63A14AA3 causes the excursion voltage to return to zero. Closed contacts 1a-1c of this relay open to de-energize excursion-on relay 63A14AA4. Contacts 2a-2c of relay 63A13AA4 open to de-energize reference input relay 63A14J2 (5.5.1.1, sect. 1). Contacts of relay 63A14J2 perform the following functions:

a. Contacts 3a-3b close to connect the amplidyne reference input to amplidyne neutral (5.5.8.1, sect. 1).
b. Contacts 1a-1c open to extinguish the EXCURSION ON light at the maintenance console (5.5.11.1, sect. 11).

3.7.3 Deselecting Cam Unit 63A9

Energizing excursion-stop relay 63A14AA3 initiates a cam-unit deselection process. Contacts 2a-2c close to complete the circuit to cam-start relay 63A14J5. Contacts 3a-3c of relay 63A14J5 close and energize cam clutch 63A9 when contacts 1a-1c of zero-sense relay 63A14AA9 close. Relay 63A14AA9 is energized when the amplidyne output is less than 0.75V. This condition prevents the damage to the contacts of the MC relays which would result if the contacts were transferred with a voltage applied.

Energizing cam clutch 63A9 starts a cam rotation cycle which opens the hold circuits for the selection relays. The relays de-energized by this cam rotation cycle are discussed below.

3.7.3.1 Safe-Limit Deselection

Safe-limit relays 63A14K1 through 63A14K10 and relay 63A14J9 are de-energized when cam 63A9(C11) opens its contacts at 254 degrees of cam rotation (5.5.6.1). Dropping the safe-limit relays disconnects the reference input voltage at the voltage-divider network in the input control circuit (5.5.8.1).

The previously-selected +10V and —100V safe-limit 63A14K4 and 63A14K9, respectively, are de-energized at this time. Contacts 5a-5b of relay 63A14K4 close to connect the reference input to amplidyne neutral through contacts 2a-2c of 16V excursion relay 63A14F8.

3.7.3.2 MC Relay Deselection

The selected MC relays drop when cams 63A9(C8), 63A9(C9), and 63A9(C10) open their contacts at 270 degrees of cam rotation (5.5.7.2). The excursion voltage is at zero when these relays transfer (par. 3.7.3).

3.7.3.3 Mode Relay Deselection

Calculator-mode relays 63A14Y23 and 63A14Y24 are de-energized when cam 63A9(C5) opens its contacts at 315 degrees of cam rotation (5.5.5.1). Calculator-mode relays 63A14C6 and 63A14J8 remain energized through the mechanically held contacts of the CALCULATOR selector pushbutton. Relays 63A14C6 and 63A14J8 enable a subsequent excursion sequence to be initiated by the MC program in the Central Computer.

3.7.3.4 Circuit-Group Relay Deselection

The selected circuit group relays (63A14Z21 and 63A14DD9 through 63A14DD12) drop when cam 63A9(C4) opens its contacts at 320 degrees of cam rotation (5.5.3.4). This cam also controls the hold circuit for the selected line-group relays (par. 3.7.3.5).

3.7.3.5 Line-Group Relay Deselection

The selected line-group relays (63A14Z10 and (3A14Z16) drop when cam 63A9(C4) opens its contacts at 320 degrees of rotation (5.5.3.1). This cam also controls the hold circuit for the selected circuit-group relays (par. 3.7.3.4).

3.7.3.6 Voltage Contactor Deselection

The transfer coil of the voltage contactor (relay 63A12B for +250V) is de-energized when cam 63A9 (C23) opens its contacts at 295 degrees of cam rotation (5.5.10.1). The back coils of the remaining voltage contactors remain de-energized until the +250V voltage relay 63A14AA13 is de-energized when cam 63A9(C18) opens its contacts at 360 degrees of cam rotation (5.5.3.2 and par. 3.7.3.7). After the contacts of the voltage relay transfer to the normally closed position, the contacts of cam 63A(C23) close at 45 degrees and energize the back coil of each voltage contactor to prevent accidental transfer of the voltage-contactor contacts.

3.7.3.7 Voltage-Group Relay Deselection

The selected voltage-group relay (relay 63A14AA-13 for +250V) drops when contacts of cam 63A9(C18) open at 360 degrees of cam rotation (5.5.3.2).

3.7.3.8 MC Equipment Group Relay Deselection

The selected MC equipment group relays (63A14CC9, 63A14CC10, and 63A14Y1) and MCD isolation relays (63A14Y5 through 63A14Y11) drop when the contacts of cam 63A9(C2) open at 345 degrees of cam rotation (5.5.3.3).

3.7.3.9 Deselection of Calculator-Controlled Relays

The selection relays energized by the RYD's in the Central Computer are de-energized when the contacts of cam 63A9(C19) open at 130 degrees of cam rotation. The hold circuit for the group-selection relays is also controlled by this cam. The instruction- and excursion-control relays are dropped during the rotation cycle of cam unit 63A10.

3.7.4 Deselecting Cam Unit 63A10

A deselection sequence in the calculator mode requires a rotation of cam unit 63A10 to de-energize the calculator selection and control relays. This rotation is initiated when cam clutch 63A10 is energized through the contacts of cam 63A9(C20) (which close at 110 degrees of cam rotation), through contacts 2a-2c of stop-excursion relay 63A14BB1, and through closed contacts of cam 63A10(C8).

When cam unit 63A10 rotates, the hold circuits are opened for those selection relays used only in the calculator mode.

3.7.4.1 Excursion Duration Deselection

The duration of the excursion in calculator mode is controlled by excursion-duration timers 63A14C1 and 63A14C2. The duration timers are energized through contacts 3a-3c and 5a-5c of relay 63A14G3 (5.5.2.3). This relay is de-energized during the stop-excursion cycle when the contacts of cam 63A10(C6) open at 250 degrees of cam rotation (5.5.1.2). Cam 63A10(C6) also controls the hold circuits of minus-polarity relays 63A14H1 and 63A14H2 and of the excursion-magnitude relays.

3.7.4.2 Excursion Polarity Deselection

Minus-polarity relays 63A14H1 and 63A14H2 are de-energized when cam 63A10(C6) opens at 250 degrees of cam rotation. Cam 63A10(C6) also controls the hold circuits of duration relay 63A14G3 and the hold circuits of the excursion-magitude relays.

3.7.4.3 Excursion Magnitude Deselection

The selected excursion-magnitude relay (16V relay 63A14F8) is de-energized when the contacts of cam 63A10(C6) open at 250 degrees of cam rotation (5.5.8.2). This cam also controls the hold circuits of duration relay 63A14G3 (par. 3.7.3.1) and minus-polarity relays 63A14H1 and 63A14H2 (par. 3.7.4.2).

3.7.4.4 Calculator-Controlled Relay Deselection

The selected calculator-controlled relays drop when the contacts of cam 63A10(C3) open at 230 degrees of cam rotation (5.5.4.1). Only the hold circuits for the start-excursion relays and the excursion-control relays are controlled by cam 63A10(C3). The hold circuit for the equipment-group relays is controlled by cam 63A9(C19).

3.8 STOP AMPLIDYNE SEQUENCE

3.8.1 Stopping After an Excursion

Depressing the STOP AMPLIDYNE pushbutton initiates a sequence which de-energizes the MC system and leaves it in a power-on status. If the pushbutton is depressed when no excursion sequence is in progress, the pushbutton will open the hold circuit to amplidyne-on relays 63A14D6 and 63A14AA6 (5.5.1.1, sect. 7). De-energizing these relays causes all the circuits dependent upon these relays to be restored to the condition present before the amplidyne was energized (par. 2.3).

If the STOP AMPLIDYNE pushbutton is depressed during an excursion sequence, the amplidyne-stop-interlock circuit prevents the amplidyne circuits from being de-energized until a stop-excursion sequence is completed.

3.8.2 Stopping During An Excursion

The amplidyne-stop-interlock circuit functions when an attempt is made to de-energize the amplidyne during an excursion sequence. The contacts of the amplidyne-stop relay initiate a stop-excursion sequence and delay the de-energization of the amplidyne circuits until this stop-excursion sequence is completed.

During an excursion sequence, the STOP AMPLIDYNE pushbutton cannot cause the amplidyne-on relays to drop because these relays are held by contacts 2a-2c of excursion-on-delay relay 63A14AA5 (5.5.1.1, sect. 6). Relay 63A14AA5 is energized by contacts 7-8 of start-excursion relay 63A14C7 and cam 63A9(C3). This alternate hold circuit prevents the amplidyne-on relays from dropping until the excursion-on delay relay is dropped during the deselection of cam unit 63A9.

If the STOP AMPLIDYNE pushbutton is depressed during an excursion, normally open contacts 2a-2c of the pushbutton close to complete the pick circuit for amplidyne-stop interlock relay 63A14AA7. This relay is also picked during an excursion sequence if the service- and capacitor-CB on relay drops as the result

of an open CB. When relay 63A14AA7 is energized, its contacts perform the following functions:

a. Contacts 1a-1c and 2a-2c close to provide a hold circuit for relay 63A14AA7 through cam 63A9 (C16). This cam does not make contact until 325 degrees of cam rotation. The hold circuit is maintained until that time by contacts 6a-6c of excursion-on delay relay 63A14AA5 which drops at 345 degrees of cam rotation. The hold circuit through cam 63A9(C16) is held until 240 degrees of cam rotation, shortly before the cam cycle is completed.
b. Contacts 5a-5c close to complete the energizing circuit to excursion-stop relay 63A14AA3 (5.5.1.1, sect. 3).
c. Contacts 4a-4c close to maintain a hold circuit for relay 63A14AA7 after the contacts of the excursion-on-delay relay open (5.5.1.1, sect. 6). This hold circuit is through the closed contacts 2a-2b and 1a-1b of the START AMPLIDYNE pushbutton and cam 63A9(C14). This circuit is significant only after the excursion-stop sequence is completed because the relay is held through alternate circuits until the cam cycle is completed. Therefore, the START AMPLIDYNE pushbutton is effective in opening a hold circuit to the amplidyne-stop-interlock relay only after the excursion has been stopped.
d. Contacts 3a-3b open to de-energize the hold circuit of test relay 63A14D24. Contacts of the interlock relay open the circuit even though cam-start relay 63A14AA2 is normally energized in the calculator mode. This action prevents the MC program from initiating an excursion at this time.

SECTION 4
MANUAL MODE EXCURSION SEQUENCES

4.1 INTRODUCTION

This section discusses the circuits employed in the selection, application, and control of an excursion during the manual mode of operation. In the manual mode of operation, the specific operations of an excursion sequence are initiated and controlled by pushbuttons and switches on the duplex maintenance console rather than by RYD's conditioned by an MC control word.

Before excursion sequences can be initiated, the amplidyne and its associated circuitry must be operating and the MC system must be receiving power. These conditions are fulfilled when the CONTROL CIRCUIT BREAKER lamp, the AMPLIDYNE READY lamp, and the READY lamp on the duplex maintenance console are lit (par. 3.1).

After the above lamps are lit, the manual mode of operation is selected by depressing the MANUAL pushbutton on the maintenance console. Depressing this pushbutton conditions the energizing circuit for manual-mode relays 63A14Y20 and 63A14H4. These relays are not energized until after the EXCURSION START pushbutton is depressed and cam 63A9(C6) closes its contacts at 330 degrees of cam rotation (5.5.5.1).

When manual mode relays 63A14Y20 and 63A-14H4 are energized, their contacts perform the following functions:

a. Contacts 5a-5c of 63A14H4 close to connect the output of the potentiometer at the MC control panel to the reference-input circuit (5.5.8.1, sect 2).
b. Contacts 2a-2c and 3a-3c of 63A14H4 close to connect the manual-mode divider network to the potentiometer (5.5.8.1, sect. 3).
c. Contacts 4a-4c of 63A14H4 close to condition the energizing circuit of reference-input relay 63A14J2 (5.5.1.1, sect. 1).
d. Contacts 3a-3c of 63A14Y20 close to condition the no-two interlock circuit so that a second mode selection cannot be made (5.5.1.3, sect. 11).
e. Contacts 2a-2c of 63A14Y20 close to illuminate the MANUAL mode light on the MC control panel (5.5.11.1, sect. 9).

4.2 SELECTING EQUIPMENT FOR TESTING

In the manual mode, the equipment group, voltage group, circuit group, and line group to be marginally checked must be designated by actuating the pushbuttons or switches associated with the desired selection. The selection relays are energized when the START EXCURSION pushbutton is depressed. A typical selection, which is discussed below, is: MC equipment group 1, +250V, circuit C, line 4. This is the same selection that was used to illustrate the calculator mode of control.

4.2.1 Equipment-Group Selection

An equipment group is selected by depressing the pushbutton associated with the desired group. Only one MC equipment group may be selected. When the MEMORY (MC equipment group 1) pushbutton is depressed, the energizing circuits of the MC group relays and the MCD unit 19 isolation relays are conditioned by contacts 1a-1c of the pushbutton. These relays are not energized until the START EXCURSION pushbutton is depressed after a complete MC selection is made, and cam 63A9(C1) closes its contacts at zero degrees of cam rotation (par. 3.3.1).

4.2.2 Voltage-Group Selection

A voltage group is selected by depressing the pushbutton associated with the desired voltage group. Only one voltage group may be selected at any one time. When the +250 (+250V-voltage group) pushbutton is depressed, contacts 1a-1c of the pushbutton condition the energizing circuit of +250V relay 63A14AA13 (5.5.3.2). This relay is not energized until an excursion is started and the contacts of cam 63A9(C3) close at 20 degrees of cam rotation (par. 3.3.2).

4.2.3 Circuit-Group Selection

A circuit group is selected by closing the switches associated with the desired circuit groups. Any number of circuit-group selections may be made simultaneously. If none are made, all circuits are automatically selected.

Assuming that only circuit-group C is selected, the energizing circuits of relays 63A14Z21 and 63A14DD9 through 63A14DD12 are conditioned by contacts 4a-4c of the switch. Contacts 2a-2b of the switch are opened simultaneously to prevent the relays associated with the remaining circuit groups from being energized unless their associated switches are closed. The relays of the selected circuit groups are energized when cam 63A9 (C13) closes its contacts at 40 degrees of cam rotation.

4.2.4 Line-Group Selection

A line-group selection is controlled by switches on the duplex maintenance console. One switch is associated with each line group. Any number of line-group switches may be selected simultaneously. If no specific group is selected, all line groups receive the excursion voltage.

Assuming that only line-group 4 is selected contacts 3a-3c of the associated switch condition the energizing circuit of line-select relays 63A14Z10 and 63A14Z16. Contacts 1a-1c of the switch open simultaneously to prevent all the relays associated with other line groups from energizing unless other line-group selections are made.

The selected line-group relays are not energized until the contacts of cam 63A9(C13) close at 40 degrees of cam rotation during an excursion sequence.

4.3 NO-TWO INTERLOCK CIRCUIT

The no-two interlock circuit detects the selection of more than one control mode, MC equipment group, or voltage group. If such a selection is made, the no-two interlock circuit initiates an excursion-stop sequence and lights the SEQUENCE FAULT indicator on the MC control panel.

No-two interlock relay 63A14AA10 is energized when power is applied to the Marginal Checking System (5.5.1.3). The relay is energized through:

a. Normally closed contacts 3a-3b of manual-mode relay 63A14Y20
b. Normally closed contacts 4a-4b of satellite-mode relay 63A14Y21
c. Normally closed contacts 3a-3b of voltage and MC selected relay 63A14AA12
d. Normally closed contacts of the MC equipment-group relays 63A14CC10, 63A14CC12, 63A14-CC14, 63A14CC16, 63A14CC18, 63A14CC20, 63A14X18, and 63A14Y13.
e. Normally closed contacts 6a-6b of amplidyne-on relay 63A14AA6.

A hold circuit is provided through contacts 2a-2c of the energized no-two interlock relay so that the relay will not be de-energized when contacts 6a-6b of amplidyne-on relay 63A14AA6 open during a start-amplidyne sequence.

4.3.1 Monitoring Mode Selection

Before the excursion is started, the no-two-interlock circuit can detect the selection of more than one mode of control. The normal energizing circuit for relay 63A14AA10 is through normally closed points of the manual- and satellite-mode relays. If the manual mode is selected, the energizing circuit is through now closed contacts 3a-3c of the manual-mode relay, normally closed contacts 3a-3b of the satellite-mode relay, and normally closed contacts 6a-6b of calculator-mode relay 63A14-Y23. If either the satellite or calculator mode is selected while the manual mode is selected, the circuit will be broken and relay 63A14AA10 will drop.

4.3.2 Monitoring MC Equipment-Group Selection

The no-two-interlock circuit also detects a selection of two or more MC equipment groups. The normal energizing circuit for the interlock relay is through one set of normally closed contacts of each of the MC group relays. When one MC equipment group is selected the energizing circuit is transferred to the second set of normally closed contacts of the remaining relays. For example, when equipment group 1 is selected, contacts 1a-1c of relay 63A14CC10 close to transfer the energizing circuit to the second set of equipment-group-relay contacts. If a second equipment group is selected, the circuit to 63A14AA10 is broken. For example, if equipment group 1 has been selected and equipment group 4 is also selected, contacts 2a-2c of relay 63A14-CC6 will close and contacts 1a-1b will open. Since the latter points are in the energizing circuit established when equipment group 1 was selected, the circuit to the no-two-interlock relay is broken, and the relay is de-energized.

4.3.3 Monitoring MC/Voltage Selection

After the selections are made and an excursion is initiated, contacts 3a-3b of voltage and MC selected relay 63A14AA12 open. The energizing circuit for the no-two-interlock relay is through the now closed contacts of the MCD isolation relay, the now closed contacts of the selected intermediate relay, and the normally closed contacts of the remaining intermediate relays in that particular MC group. A second voltage selection will energize a second intermediate relay, and cause the interlock relay to be de-energized (5.5.1.3).

Since the voltage and MC relay cannot be picked unless a voltage selection is made, the intermediate relays function in the no-two-interlock circuit only if a voltage is selected. The absence of a voltage selection is detected by the voltage and MC-selected circuit (par. 4.4).

4.3.4 No-Two-Interlock Action

When more than one mode, equipment group, or voltage group is selected the hold circuit for relay 63A14AA10 is broken and the relay drops. The normally closed contacts of this relay perform the following functions:

a. Contacts 3a-3b close to complete the circuit to excursion-stop relay 63A14AA3 (5.5.1.1, sect. 3).
b. Contacts 4a-4c open to extinguish the READY light on the maintenance console (5.5.11.1).

c. Contacts 5a-5b close to light the SEQUENCE FAULT light on the maintenance console (5.5.1.11).

4.4 VOLTAGE AND MC-SELECTED CIRCUIT

The voltage and MC-selected circuit detects the absence of an MC equipment-group selection or a voltage-group selection. This circuit detects these omissions after an excursion is begun.

4.4.1 Monitoring Voltage Selection

The energizing circuit of voltage and MC selected relay 63A14AA12 is conditioned by contacts of the selected voltage contactor (5.5.1.1, sect. 11).

If a voltage has been selected, the relay will be energized when the contacts of cam 63A9(C17) close at 180 degrees of cam rotation. If no voltage is selected, the relay cannot be energized, and an interlock action will take place (par. 4.4.3).

No provision is made in this circuit to detect a multiple voltage-group selection. The selection of more than one voltage group is detected by the no-two-interlock circuit (par. 4.3).

4.4.2 Monitoring MC Group Selection

Relay 63A14AA12 is held energized by its own contacts 2a-2c and contacts of the selected MC-group relay. Since the MC-group selection should be made before the voltage and MC-selected relay is energized, the hold circuit is completed before the normally open contacts 2a-2c of relay 63A14AA12 are transferred. If no MC-equipment-group selection is made, relay 63A14AA12 will de-energize when cam 63A9(C17) opens its contacts at 216 degrees of cam rotation. If relay 63A14AA12 drops, an interlock action takes place (par. 4.4.3).

4.4.3 Interlock Action of Voltage and MC Selection Circuit

The interlock action of this circuit results from the fact that no MC group or no voltage group is selected. If a voltage group is not selected, the intermediate relays are not energized because the points of all voltage-group-selection switches are open (5.5.13.1). If no MC group is selected, the MC group relays cannot be energized because the points of the MC-equipment-group-selection pushbuttons are open (5.5.3.3).

If either an MC equipment group or a voltage group is not selected, relay 63A14AA12 will not remain energized. Contacts of the relay cause the following actions to occur:

a. Contacts 3a-3c close to bypass the portion of the no-two-interlock circuit that normally monitors the voltage/MC group selection (5.5.1.3), and keeps no-two interlock relay 63A14AA10 energized.

b. Contacts 1a-1c open to extinguish the EXCURSION-ON lamp (5.5.11.1).

4.5 EXCURSION-START SEQUENCE

An excursion is started in the manual mode by depressing the START EXCURSION pushbutton (5.5.1.1, sect. 4 and fig. 3–11). Normally open contacts 1b-1c of the START EXCURSION pushbutton close to complete the energizing circuits to cam-start relays 63A14AA2 and 63A14J5. Both relays are energized through closed contacts of cam 63A9(C14), contacts a-b of the STOP EXCURSION pushbutton, contacts of cam 63A10(C17), contacts 1a-1b of the START EXCURSION pushbutton, contacts 12-13 of calculator mode relay 63A14C6, contacts 3a-3c of amplidyne-control-CB relay 63A14AA11, contacts 2a-2c of test relay 63A14DD24, and contacts 2a-2c of recycle-interlock relay 63A14AA1 (5.5.1.1, sect. 4).

The contacts of relays 63A14AA2 and 63A14J5 energize the clutch of cam 63A9 which causes the cams to rotate to complete the selection of the equipment to be marginally checked (par. 4.2).

In manual-mode operations, cam unit 63A10 is not rotated because excursion magnitude, polarity, and duration are controlled manually.

4.6 EXCURSION CONTROL

In manual mode, the magnitude, polarity, and duration of an excursion are controlled by the operator at the duplex maintenance console. Control is accomplished by varying a potentiometer and observing the voltage variation on a voltmeter.

4.6.1 Reference Input Circuit

The 125V reference voltage is connected to the amplidyne control circuit through the following portions of the reference input circuit: contacts of the ±125V interlock relay 63A14J1, contacts of the selected safe-limit relays, and the manual excursion potentiometer (5.5.8.1). Refer to Paragraph 2.3.5, Section 2, for the process of connecting the reference-voltage power supply output to the reference-input circuit.

4.6.2 Safe Limit Selection

The safe-limit selection circuit protects the circuits being marginally checked from excessive increases or decreases in voltage. The safe-limit selection is made at the voltage-divider network in the reference input control circuitry.

Two voltage-divider networks are provided for the manual mode of operation. Each voltage-divider network is connected to the output of a reference-voltage power supply. One network is used with the +125Vdc supply; the other with the −125Vdc supply. Each network is tapped to provided voltage levels of 0, 25, 50, 75, and 100 volts. The polarity of the safe-limit voltage

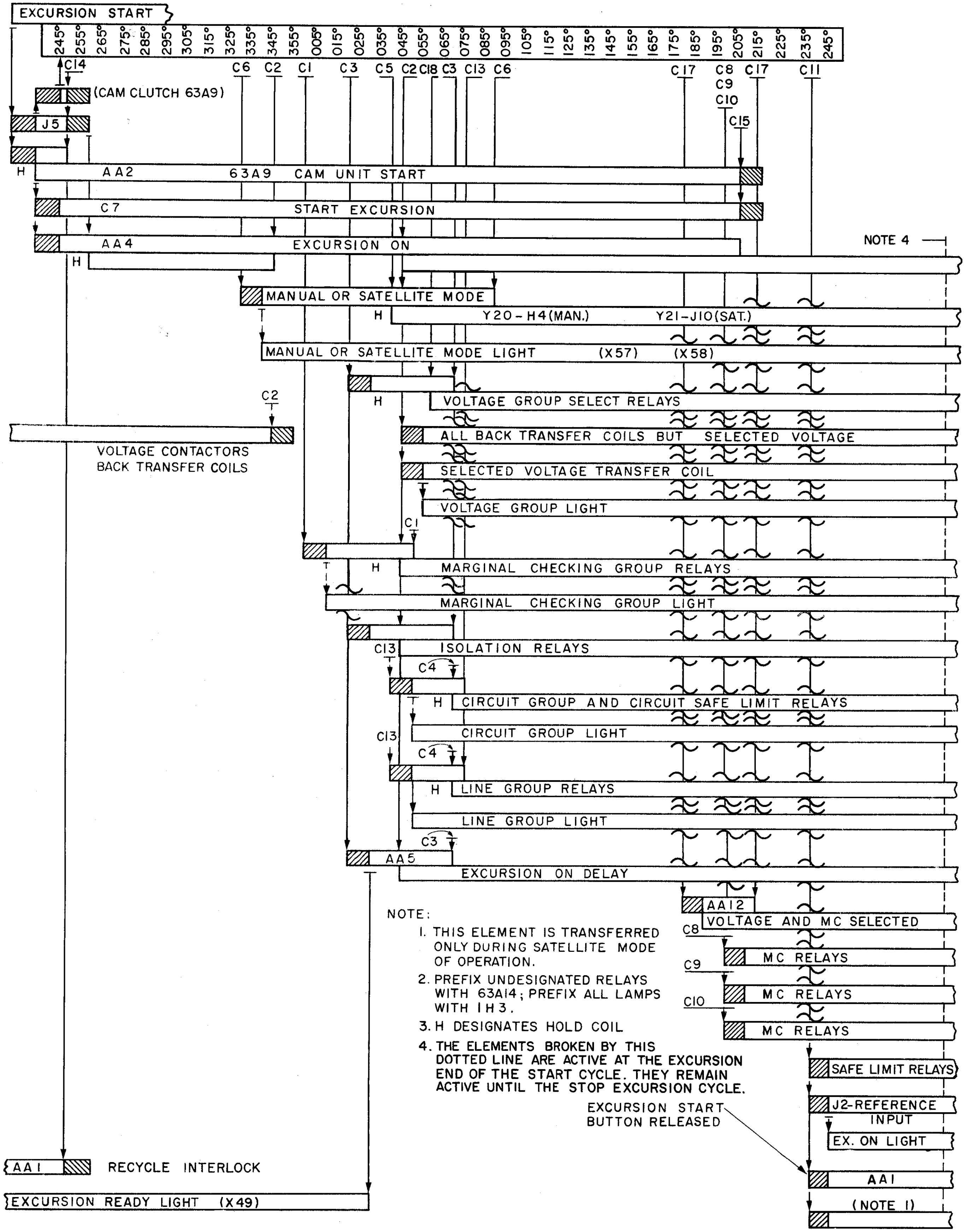


Figure 3–11. Duplex Start-Excursion Sequence, Manual Mode, Simplified Sequence Chart

corresponds to the polarity of the network. The method of selecting a safe limit in manual mode is the same as that in calculator mode. This process is discussed in paragraph 3.4.3, Section 3.

4.6.3 Excursion Polarity Control

The excursion voltage either increases or decreases the voltage applied to a circuit during an MC test. The direction of voltage variation depends upon the polarity of the reference input voltage to the amplidyne.

In manual mode, the polarity of the reference input voltage is controlled by the direction of rotation of the excursion-potentiometer control. A clockwise rotation of the control causes the excursion to increase in the positive direction; a counterclockwise rotation causes an increase in the negative direction.

4.6.4 Excursion Magnitude Control

In manual mode, the magnitude of the excursion is controlled by manual operation of the potentiometer mounted on the MC control panel. Three complete revolutions of the potentiometer control move the adjustable contactor from one extreme of the potentiometer to the other. The voltages tapped off the voltage-divider network by the safe-limit selections (par. 4.6.2) are connected to opposite ends of the potentiometer (5.5.8.1). The center of the potentiometer is connected to ground potential. The movable contactor is connected to the manual-mode reference input line. From the zero-voltage point (the midpoint of the divider) the potentiometer-control knob can be moved in either direction to control the magnitude of the excursion voltage. The direction of movement determines the polarity of the excursion voltage (par. 4.6.3); the amount of movement determines the magnitude of the excursion voltage. Since only the safe-limit voltage is applied to the potentiometer, the excursion voltage can never exceed the safe-limit voltage.

A voltmeter installed in the MC control panel is connected to the amplidyne output. The amount of excursion voltage applied to the circuits is registered on this meter.

4.6.5 Applying The Excursion

The voltage contactors and the MC relays perform the same functions in both manual and calculator mode of control (par. 3.5.6).

4.6.6 Excursion Duration Control

In the manual mode, the duration of the excursion is controlled by the potentiometer at the MC control panel of the duplex maintenance console. An excursion will remain on the selected circuits until the excursion voltage is returned to zero by operating the potentiometer control. The amount of excursion is determined by observing the EXCURSION VOLTMETER mounted above the potentiometer control.

4.7 CHANGE EXCURSION SEQUENCE

In manual mode, the excursion voltage is varied by changing the setting of the excursion-control potentiometer. The magnitude of the excursion voltage is determined by the distance the movable contact is moved from the center or 0-voltage position. The duration of the excursion voltage is determined by the length of time the setting of the potentiometer remains constant. Therefore, a change-excursion sequence in manual mode consists of changing the setting of the potentiometer on the maintenance console.

4.8 STOP-EXCURSION SEQUENCE

The stop-excursion sequence is initiated by energizing stop-excursion relay 63A14AA3 (5.5.1.1, sect. 3). This relay is energized in all modes of control during the stop-excursion sequence. Relay 63A14AA3 is energized in manual mode by depressing the STOP EXCURSION pushbutton. The relay is energized through contacts a-c of the pushbutton and contacts 4a-4c of relay 63A14AA1. When relay 63A14AA3 is energized, cam unit 63A9, the safe-limit relays, the MC relays, the mode relays, the line-group relays, the voltage contactors, the MC equipment-group relays, and the voltage-group relays are deselected. These deselection processes are identical in both the manual and the calculator mode (par. 3.7.3, through 3.7.3.8).

PART 4
SIMPLEX MC SYSTEM
CHAPTER 1
INTRODUCTION

1.1 GENERAL

Part 4 describes the operation of the simplex MC system. The distribution of a typical MC d-c voltage and the control sequences are discussed. Each sequence in the operation of the simplex system is described under one of the following major MC operations: Power On, Start Amplidyne, Start Excursion, Excursion Control, Stop Excursion, and Stop Amplidyne.

The operation of the simplex MC system is similar to that of the duplex MC system. However, in calculator mode, the simplex MC system must be operated through the duplex system. Other differences between the two systems occur in the physical location of the components, and in the additional components required in the simplex system to permit control-line switching during calculator-mode operations. These differences are summarized in Chapter 4.

1.2 SYSTEM COMPONENTS

The simplex MC system consists of the following components:

a. One amplidyne and its associated control circuitry.
b. One MC unit that contains MC relays and control equipment.
c. One MC control panel at the simplex maintenance console.
d. Other distribution components such as CB's voltage contactors, and unit status switches.
e. One portable satellite control box (at those sites equipped for satellite marginal checking).

The MC unit, the MC control panel, and the distribution components are discussed in this Part. The amplidyne and its associated circuitry is discussed in Chapter 2, Part 2.

CHAPTER 2

SIMPLEX DISTRIBUTION

2.1 GENERAL

This chapter discusses the distribution of MC voltages through the simplex MC system. A block diagram analysis is used to show the overall arrangement of voltage distribution. A typical voltage line is traced from the power supply unit through MC unit 58 to a load unit.

2.2 BLOCK DIAGRAM ANALYSIS

Figure 4–1 is a simplified block diagram of the voltage distribution in the simplex MC system. Simplex input CB unit 58 distributes and controls all voltages used during MC operations on the simplex input and crosstell (XTL) equipment. Unit 58 may receive power from either simplex power supply via unit 56.

The unit-status switch limits the distribution of the MC test voltage to those channels whose unit-status switches are in the STANDBY MC position.

The voltage-distribution contactors for distributing non-MC voltages are located in unit 55. The MC-distribution contactors, MC-voltage contactors, the MC-distribution CB's, and the MC relays are located in simplex input MC unit 58.

2.2.1 Simplex Input PD Unit 55

Unit 55 contains the voltage-distribution contactors which connect the non-MC distribution lines to the standby power system. One set of relays is associated with each simplex power system. When the associated system (for example, system C) is in standby status, one set of relays is energized and connects the standby d-c voltages to the non-MC loads in standby status. During MC operations, these contactors supply standard d-c voltages to the load circuits that are not marginally checked.

2.2.2 Simplex Input MC Unit 58

Simplex input MC unit 58 is used for distribution and control of all voltages utilized during marginal checking of the simplex XTL and input components. Marginal checking unit 58 is capable of operating from either power system C or D (fig. 4–2). This paragraph provides information on the contactors, relays, and CB's of MC unit 58.

2.2.2.1 Distribution Contactors

Two identical sets of distribution contactors are provided to permit switching of power for MC unit 58 from either simplex input CB unit C or D. Figure 4–2 shows the MC voltage-distribution system for the MC unit. The a-c voltage contactors are 3-phase contactors. All of the distribution contactors are controlled by the simplex power switch. This ensures that the MC voltages always come from the power system designated as standby.

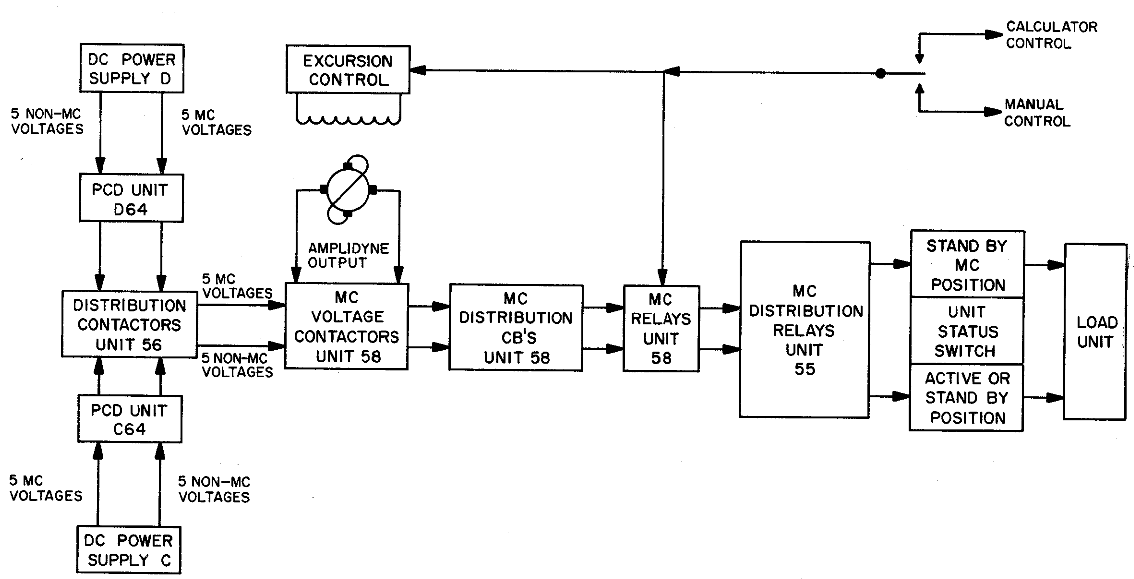


Figure 4–1. Simplex MC System, Simplified Block Diagram

2.2.2.2 MC Relays

The MC relays in MC unit 58 perform the same function in the simplex MC system as the MC relays in the MCD units in the duplex MC system. See paragraph 2.2, Part 3, Chapter 2 for the description of MC relays in the MCD units.

2.2.2.3 Marginal Checking Distribution CB's

Two MC distribution CB's are provided for each MC voltage distribution line. One CB controls the connection of the nonvariable MC input voltages to the normally closed contacts of the MC relays for normal distribution to the load circuits. The other CB controls the connection of the amplidyne output to the nor-

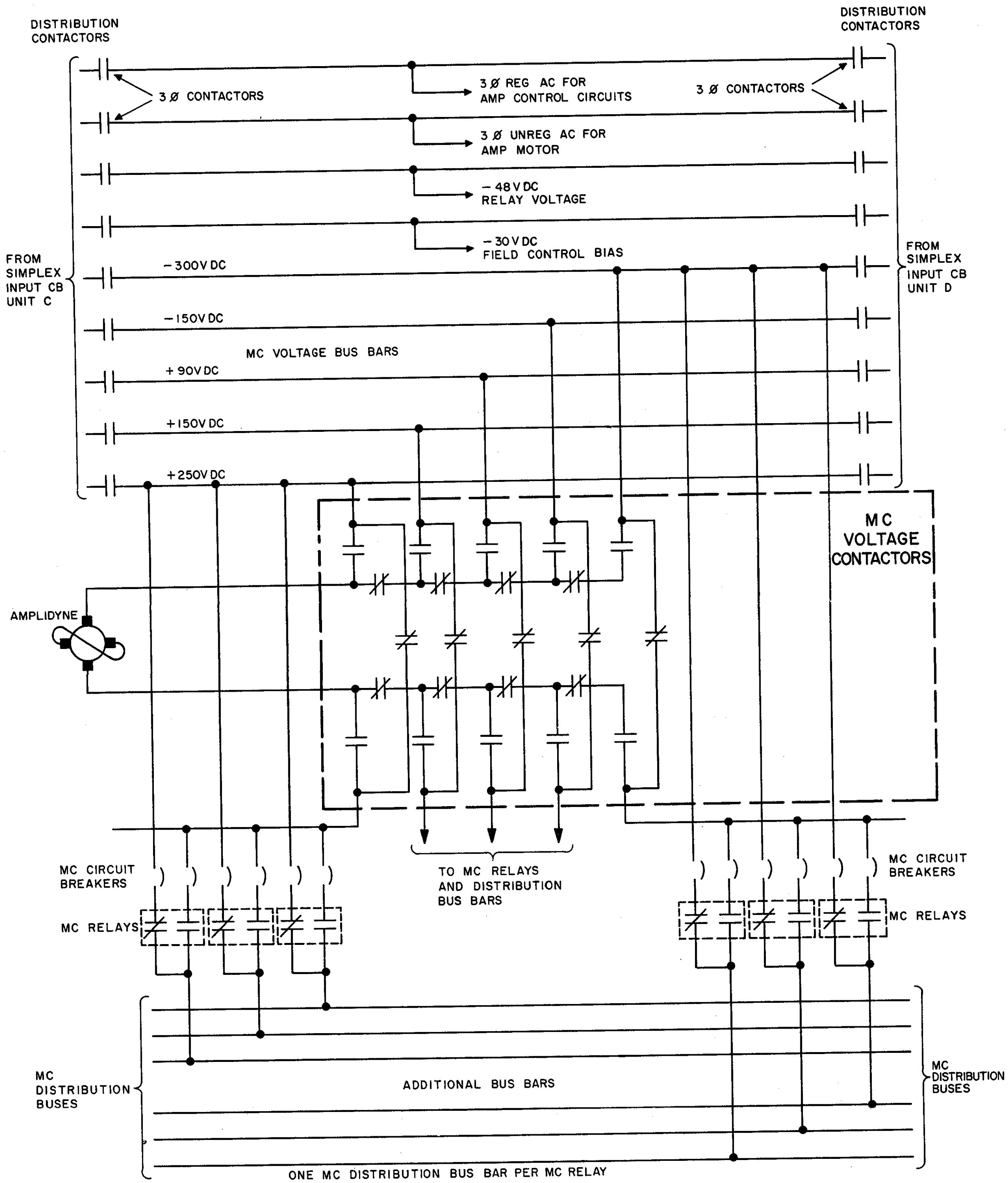


Figure 4–2. Simplex MC Voltage Distribution, MC Unit 58, Simplified Schematic

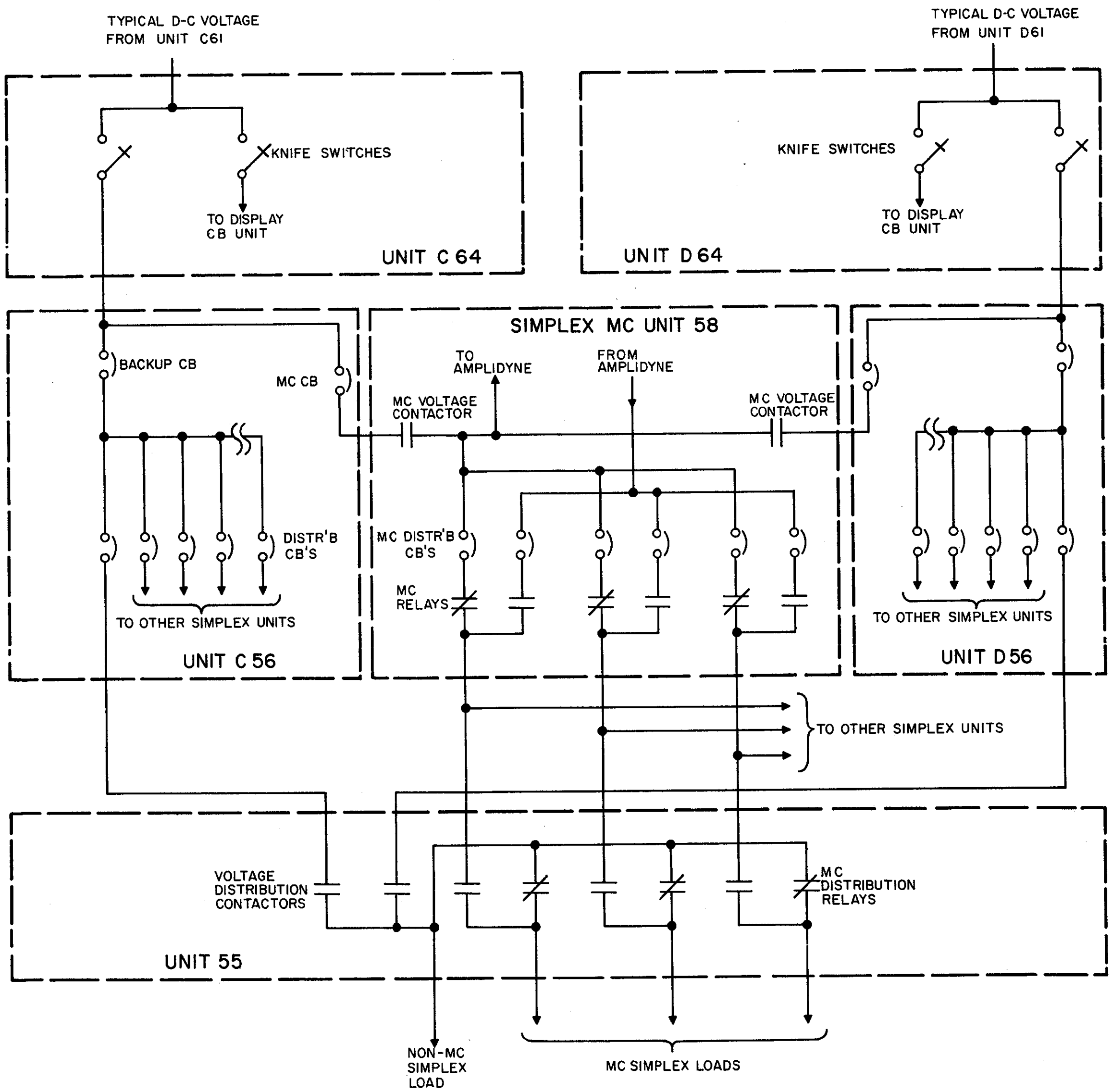


Figure 4—3. Simplex MC Voltage Distribution, Simplified Schematic

mally open contacts of the MC relays for distribution during marginal checking (fig. 4—2). Interlock circuits are included to detect CB's which might open during marginal checking.

2.2.2.4 MC-Voltage Contactors

The MC-voltage contactors in MC unit 58 perform the same function in the simplex MC system as the MC-voltage contactors in PCD unit 63 perform in the duplex MC system. See paragraph 2.2. Part 3, Chapter 2, for the description of the MC-voltage contactors in the PCD unit.

2.2.2.5 Amplidyne and Associated Circuits

A separate amplidyne is provided for the simplex MC system. The associated control units are also provided. See Part 2, Chapter 2 for the description of the amplidyne and the associated circuits.

2.3 TYPICAL DISTRIBUTION

This paragraph traces the distribution of a typical MC d-c voltage during MC operations (fig. 4—3).

The voltage is developed in unit 60 and fed to the knife switches in PCD unit 64. From unit 64, the voltage is fed through the MC CB in unit 56 to the MC-voltage contactor in simplex MC unit 58. The amplidyne output, which varies the MC voltage, is inserted in the distribution line at this point. The MC voltage is fed through an MC-distribution CB and an MC relay to the MC-distribution relays in unit 55. These relays connect the MC voltage (varied by the amplidyne) to the MC load circuits in the load units.

CHAPTER 3
SIMPLEX CONTROL

SECTION 1
CONTROLS AND INDICATORS

1.1 INTRODUCTION

This section discusses the controls and indicators found on the simplex maintenance console and simplex MC unit 58. These controls and indicators perform functions similar to the functions performed by similar controls and indicators on the duplex maintenance console and PCD unit 63.

1.2 SIMPLEX MAINTENANCE CONSOLE

The controls and indicators associated with the simplex MC system are located on the MC control panel (module J). The location of these controls and indicators is shown in figure 4—4. The functions of these components are listed in table 4—1.

A portion of a typical channel control panel is shown in figure 4—5. The unit status switch is the only component pertinent to MC-system operations. When this switch is in the STANDBY-MC position, the MC and the non-MC d-c lines from the standby power supply are connected to the MC and non-MC lines, respectively, in the simplex load units.

1.3 SIMPLEX MC UNIT 58

Module A of unit 58 (fig. 4—6) contains controls and indicators for the simplex MC system. This equipment includes amplidyne CB's, reference-voltage power supplies, voltage contactors, control CB's, meters, cam-timing units, and a dynamic timer. These components function in the same manner as the similar components found in module A of unit 63 (par. 1.3, Part 3, Ch 1).

TABLE 4—1. SIMPLEX MC CONTROL PANEL COMPONENTS

PANEL DESIGNATION	TYPE OF COMPONENT	FUNCTION
START AMPLIDYNE	Pushbutton	Starts the MC amplidyne.
STOP AMPLIDYNE	Pushbutton	Stops the MC amplidyne.
VOLTAGE SELECTOR	Interlock pushbuttons (5)	Selects a particular voltage line to be marginally checked. Only one of the five voltages is selected at any one time. This pushbutton is effective only in manual or satellite mode.
CIRCUIT GROUP SELECTOR	Lever switches (12)	Selects a particular circuit to be marginally checked. These pushbuttons are effective only in manual or satellite mode. Since they are not interlocked, any combination of pushbuttons may be selected at one time. If no pushbuttons are selected, all circuit groups will be marginally checked.
MODE SELECT	Interlock pushbuttons (4)	Selects the type of excursion and selection control to be used for marginal checking: MANUAL, SATELLITE, or CALCULATOR. Each pushbutton is interlocked so that only one may be in the selected position at one time.

TABLE 4—1. SIMPLEX MC CONTROL PANEL COMPONENTS (cont'd)

PANEL DESIGNATION	TYPE OF COMPONENT	FUNCTION
START EXCURSION	Pushbutton	Initiates an excursion sequence in manual or satellite mode. Any selection and excursion present when this pushbutton is operated will automatically be removed before a new selection is completed. This pushbutton is inoperative in calculator mode.
STOP EXCURSION	Pushbutton	Removes any selection and excursion on the MC System. This pushbutton is operative in any mode.
MANUAL EXCURSION	Potentiometer	Used to control the output of the MC amplidyne. This control is operative in manual mode only.
EXCURSION VOLTMETER	Voltmeter	Connected across output of MC amplidyne, it measures the excursion voltage applied to circuit being checked.
VOLTMETER SCALE	Lever switch	A momentary-action lever switch used to select the multiplier on excursion voltmeter. Normally, scale is ±120V; with switch operated, scale is ±30V.
RESET AMPLIDYNE SENSITROL	Lever switch	A momentary-action lever switch used to reset amplidyne output voltage Sensitrol.
VOLTAGE SELECTOR	Lights	Indicates which voltage has been selected for an excursion in any mode. The selected indicator lights after the excursion starts.
CIRCUIT GROUP SELECTOR	Lights	Indicates which circuit groups have been selected for an excursion in any mode. The selected indicator lights after the excursion starts.
MODE SELECT	Lights	Indicates which selection and excursion controls are operative on an excursion: MANUAL, SATELLITE, or CALCULATOR.
EXCURSION ON	Light	Indicates that an excursion has been applied to the selected circuit group or groups.
READY	Light	Indicates that the amplidyne is running and is ready but that no MC selection has been made.
AMPLIDYNE READY	Light	Indicates that the amplidyne is running and that the control circuits are operating.
UNIT 56C MC UNIT INPUT CB	Alarm light	Indicates that the MC input CB unit 56, has opened.
CONTROL CIRCUIT BREAKER	Light	Indicates that all —48V and +72V control CB's in the MC unit are closed.
SEQUENCE FAULT	Alarm light	Indicates a fault in excursion-on-sequence of MC System. A sequence fault automatically causes an excursion stop cycle.
UNIT 58 MC CB	Alarm light	Indicates that a CB has opened in MC unit 58.

TABLE 4—1. SIMPLEX MC CONTROL PANEL COMPONENTS (cont'd)

PANEL DESIGNATION	TYPE OF COMPONENT	FUNCTION
AMPLIDYNE SENSITROL	Alarm light	Indicates that the amplidyne has exceeded safe limit.
UNIT 56D MC UNIT CB	Alarm light	Indicates that an MC input CB unit 56 has opened.
SIMPLEX 72-VOLT	Alarm light	Indicates that the output of the 72V supply has detected an off-limits condition.
AMPLIDYNE CIRCUIT BREAKER	Alarm light	Indicates an open CB in the amplidyne output.

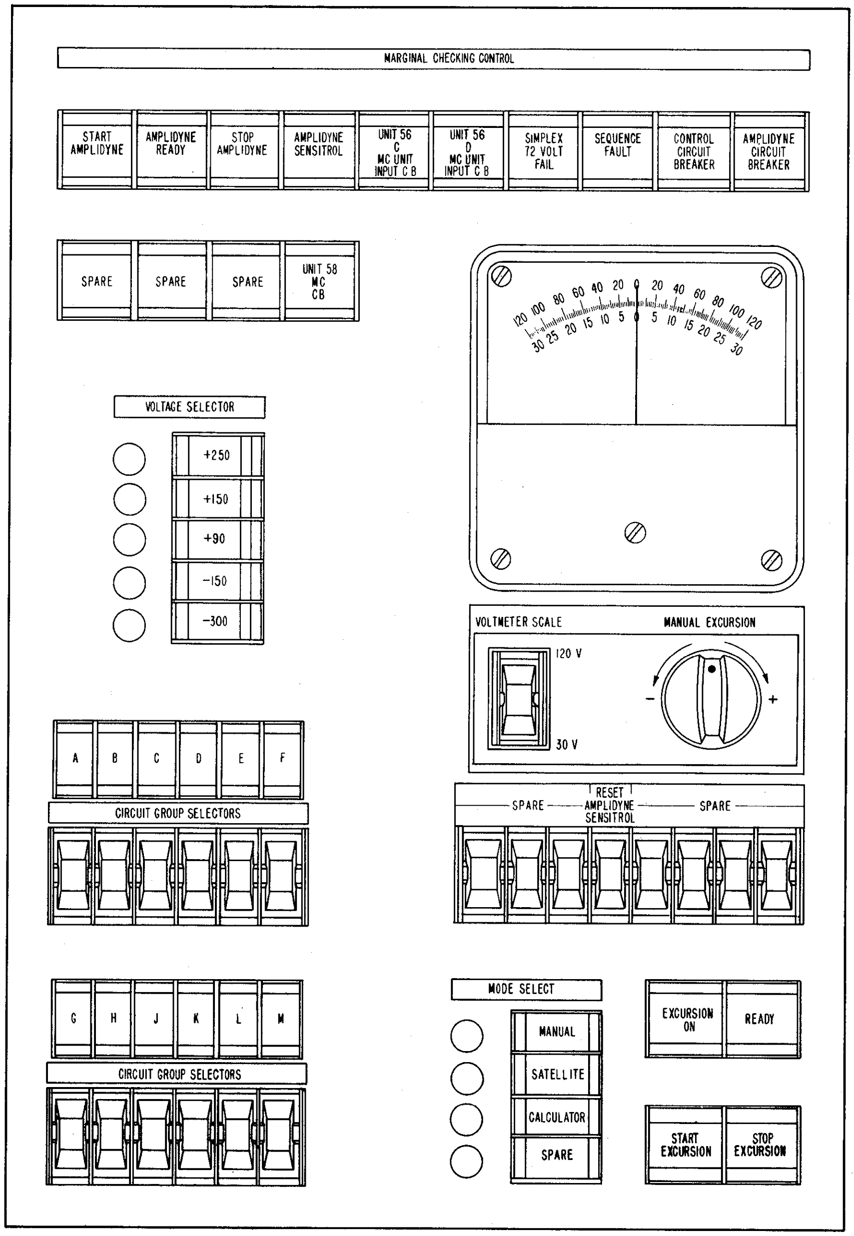


Figure 4—4. MC Controls, Module J, Simplex Maintenance Console

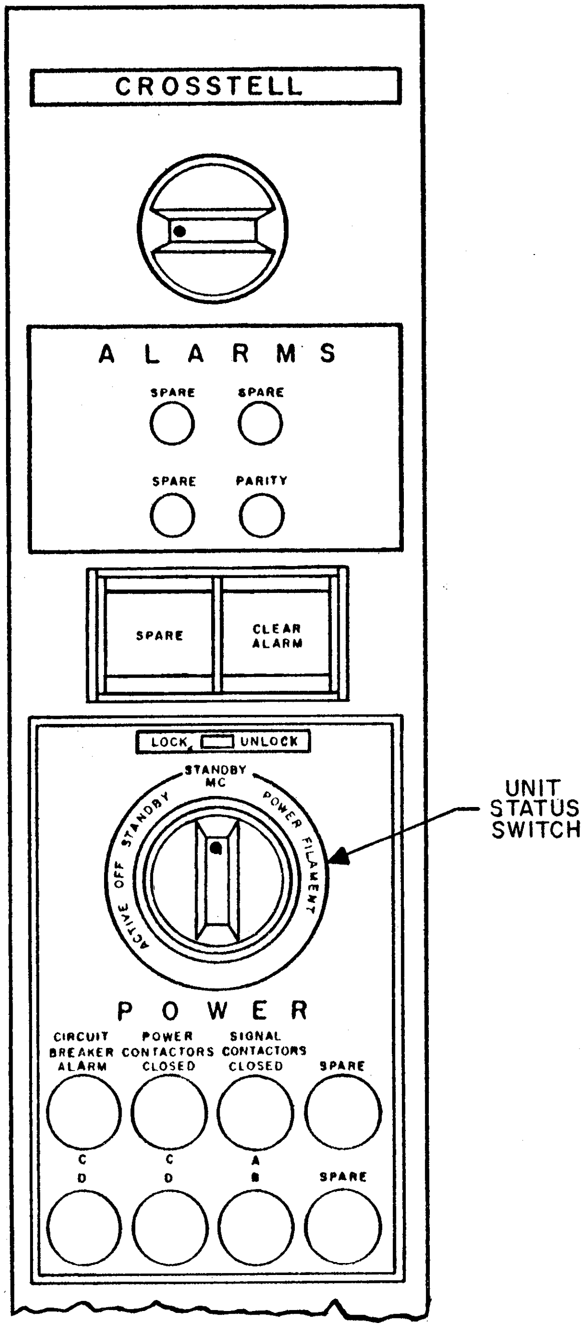


Figure 4–5. UNIT STATUS Switch On Typical Channel-Control Panel, Unit 47

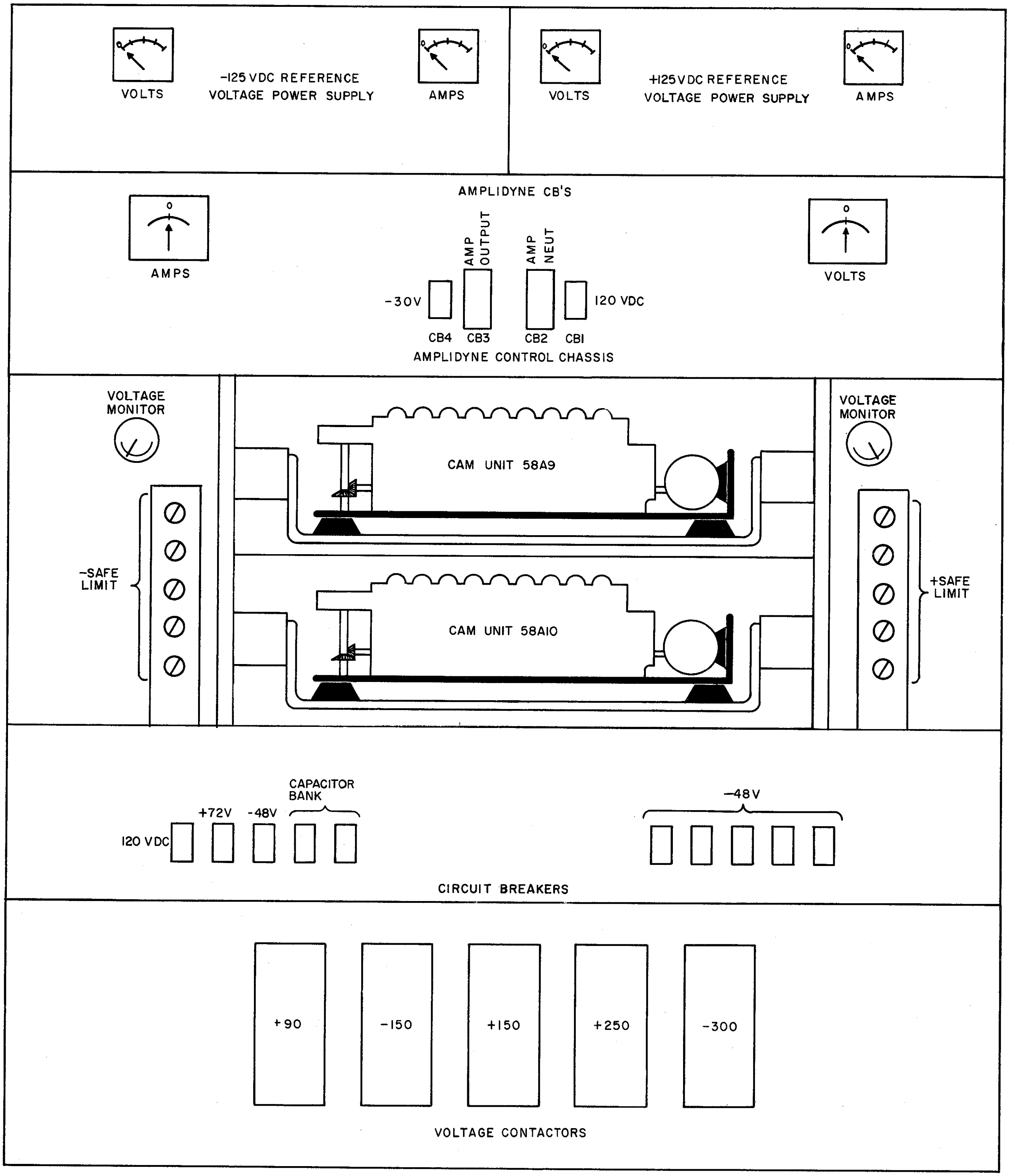


Figure 4–6. Controls and Indicators, Module A, Simplex MC Unit 58

SECTION 2

SEQUENCES TO PREPARE THE SIMPLEX MC SYSTEM FOR OPERATION

2.1 INTRODUCTION

The simplex MC system is ready for operation when power is available and the amplidyne and its associated circuits are operating.

These conditions result from the following sequences:

a. Power-on sequence

b. Start-amplidyne sequence.

2.2 POWER-ON SEQUENCE

The simplex power-on sequence is described in Part 4, Chapter 5, Section 2, *Theory of Operation, Power Supply System for AN/FSQ-7 and -8,* 3-82-0. Completing the power-on sequence and closing the CB's at simplex PCD unit 64, CB unit 56, and MC unit 58 energizes the interlocks and control circuits that place the MC system in the power-on status. In this status the MC system can be controlled from the simplex maintenance console (fig. 4—7).

2.2.1 Voltage-Contactor- and Capacitor-CB-Interlock Circuits

The voltage-contactor- and capacitor-CB-interlock circuits ensure that each of the service-voltage contactors in unit 58 are closed and that the filter capacitors are connected to the amplidyne output circuit.

When power is applied (S 5.5.1.1, sect. 8) and all CB's and voltage contactors are closed, —48Vdc is applied to control CB (amplidyne on) relay 58A14A11 and to capacitor-CB-on relays 58A14AA8 and 58A14J3. Relay 58A14AA8 is energized through contacts of the regulated-ac, unregulated-ac, —30Vdc, —48Vdc, and d-c service-voltage contactors, the capacitor CB microswitches and normally closed contacts 3a-3b of relay 58A14AA14. Relay 58A14J3 is energized through the same voltage contactors and capacitor CB microswitches and normally closed points 2a-2b of relay 58A14J4.

Contacts of relay 58A14AA8 perform the following functions:

a. Contacts 2a-2b open to disable the amplidyne-stop-interlock circuit. (S 5.5.1.1, sect. 6).

b. Contacts 4a-4c close to condition the energizing circuit of the AMPLIDYNE READY lamp (S 5.5.11.1, sect. 7).

c. Contacts 5a-5c close to condition the energizing circuit of the READY lamp (S 5.5.11.1, sect. 6).

Contacts of relay 58A14J3 perform the following functions:

a. Contacts 5a-5c close to condition the energizing circuit of amplidyne-on relays 58A14D6 and 58A14AA6 (S 5.5.1.1, sect. 7).

b. Contacts 6a-6b open to disable the excursion-stop circuit (S 5.5.1.1, sect. 5).

c. Contacts 3a-3c close to energize amplidyne-off relay 58A14AA14.

d. Contacts 5a-5c close to energize power-on relay 58A14AA15.

2.2.2 Control-CB-Interlock Circuit

The control-CB-interlock circuit functions during the power-on sequence to sense that the CB's supplying the MC system with control voltages are closed.

Control CB (amplidyne-off) relay 58A14J4 is energized through auxiliary contactor of the —48Vdc CB's, the +72Vdc CB, the regulated 120Vac CB, and contacts 2a-2c of relay 58A14AA14 (S 5.5.1.1, sect. 8). Relay 58A14J4 will not energize unless the —48Vdc, the +72Vdc, and the 120Vac CB's are closed.

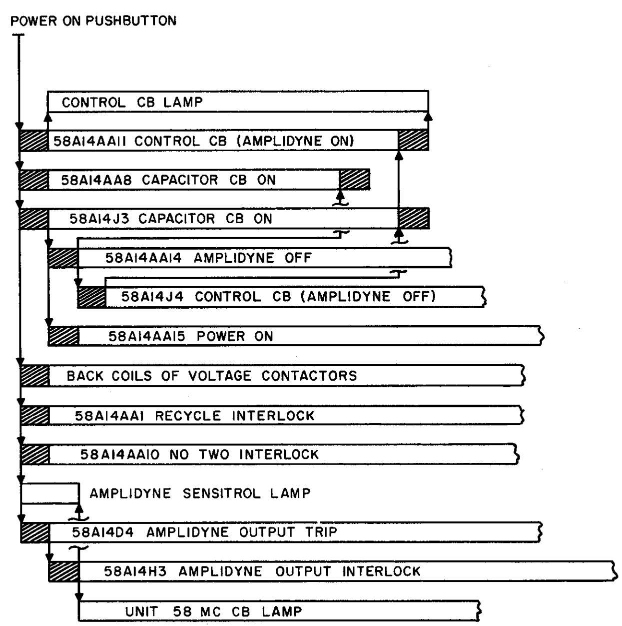


Figure 4—7. Simplex Power-On Sequence, Simplified Sequence Chart

When this relay is energized, its contacts perform the following functions:

a. Contacts 1a-1c close to form a hold circuit for the relay.

b. Contacts 2a-2b open to de-energize relay 58A14J3 (S 5.5.1.1, sect. 8).

c. Contacts 3a-3b close to hold power-on relay 58A14AA15 (S 5.5.1.1, sect. 6) energized when relay 58A14J3 is de-energized.

d. Contacts 5a-5c open to de-energize control-CB (amplidyne on) relay 58A14AA11.

When power-on relay 58A14AA15 is energized, its contacts 5a-5c close to condition the circuit to reset-FF relays AIF(K9) and BIF(K9) (S 5.5.1.2, sect. 8).

2.2.3 MC Voltage Contactors

When power is applied, the back coils of the MC-voltage contactors are energized through closed contacts of cam 58A9(C2) and normally closed contacts 4a-4b of each of the voltage-selection relays (S 5.5.10.1). Energizing the back coils of the voltage contactors ensures that the amplidyne output is not applied to a load unit through a sticking voltage contactor before the MC test is begun.

2.2.4 Recycle Interlock

The recycle interlock is actuated to permit control of the amplidyne and the MC system from the maintenance console. Recycle-interlock relay 58A14AA1 is energized through closed contacts 1a-1b of both the STOP EXCURSION and the START EXCURSION pushbuttons and closed contacts of cam 58A10(C17) (S 5.5.1.1, sects. 4 and 5).

When relay 58A14AA1 picks, the following actions occur:

a. Contacts 1a-1c close to complete a hold circuit for the relay (S 5.5.1.1, sect. 5).

b. Contacts 2a-2c close to condition the energizing circuit for cam-start relay 58A14AA2 (S 5.5.1.1, sect. 4).

c. Contacts 3a-3c close to condition a circuit that will initiate an automatic stop-excursion sequence if abnormal conditions occur (S 5.5.1.1, sect. 3).

d. Contacts 4a-4c close to condition the excursion-stop circuit so that excursion- stop relay 58A14AA3 will be energized when the STOP EXCURSION pushbutton is depressed (S 5.5.1.1, sect. 4).

e. The relay is interlocked so that a second stop cycle cannot be initiated if the STOP EXCURSION pushbutton is held depressed (S 5.5.1.1, sect. 4).

2.2.5 No-Two Interlock Circuit

The no-two interlock circuit prevents an excursion from being initiated if more than one voltage is selected. Since simplex marginal checking involves only one MC equipment group, the no-two interlock for simplex equipment does not detect multiple MC-equipment-group selecting.

2.2.6 Amplidyne Relays

Relays 58A14D4 (amplidyne-output trip) and 58A14H3 (amplidyne-output interlock) are energized during the power-on sequence. These relays function in the start-amplidyne sequence and are discussed in paragraph 2.3.8.

2.3 START AMPLIDYNE SEQUENCE

The start-amplidyne sequence begins when the START AMPLIDYNE pushbutton is depressed after power has been applied.

When the START AMPLIDYNE pushbutton is depressed, contacts 1a-1b and 2a-2b of the pushbutton open to de-energize relay 58A14AA14 (fig. 4–8). Capacitor CB-on relays 58A14AA8 and 58A14J3 are re-energized through now closed contacts 3a-3b of relay 58A14AA14.

Contacts 1a-1c and 2a-2c of the START AMPLIDYNE pushbutton are closed when the pushbutton is depressed.

2.3.1 Amplidyne-On Relays

Amplidyne-on relays 58A14D6 and 58A14AA6 are energized through contacts 1a-1c of amplidyne-output-interlock relay 58A14H3 (energized when —48Vdc was applied to the MC system), contacts 1a-1c and 2a-2c of the START AMPLIDYNE pushbutton, contacts 1a-1b and 2a-2b of the STOP AMPLIDYNE pushbutton, and contacts 5a-5c of capacitor CB-on relay 58A14J3.

When relay 58A14D6 is energized, its contacts perform the following functions:

a. Contacts 10-11 close to complete the energizing circuit to relay K1 in the MMS.

b. Contacts 12-13 open to de-energize relay 58A14J4.

c. Contacts 7-8 and 4-5 close to energize the cam motors and the reference-voltage power supplies (S 5.5.2.3).

When relay 58A14J4 is de-energized, the following are energized:

a. Control CB (amplidyne-on) relay 58A14AA11, through contacts 5a-5b.

b. AMPLIDYNE CB lamp through contacts 3a-3b (S 5.5.11.1, sect. 9).

When amplidyne-on relay 58A14AA6 is energized, its contacts perform the following functions:

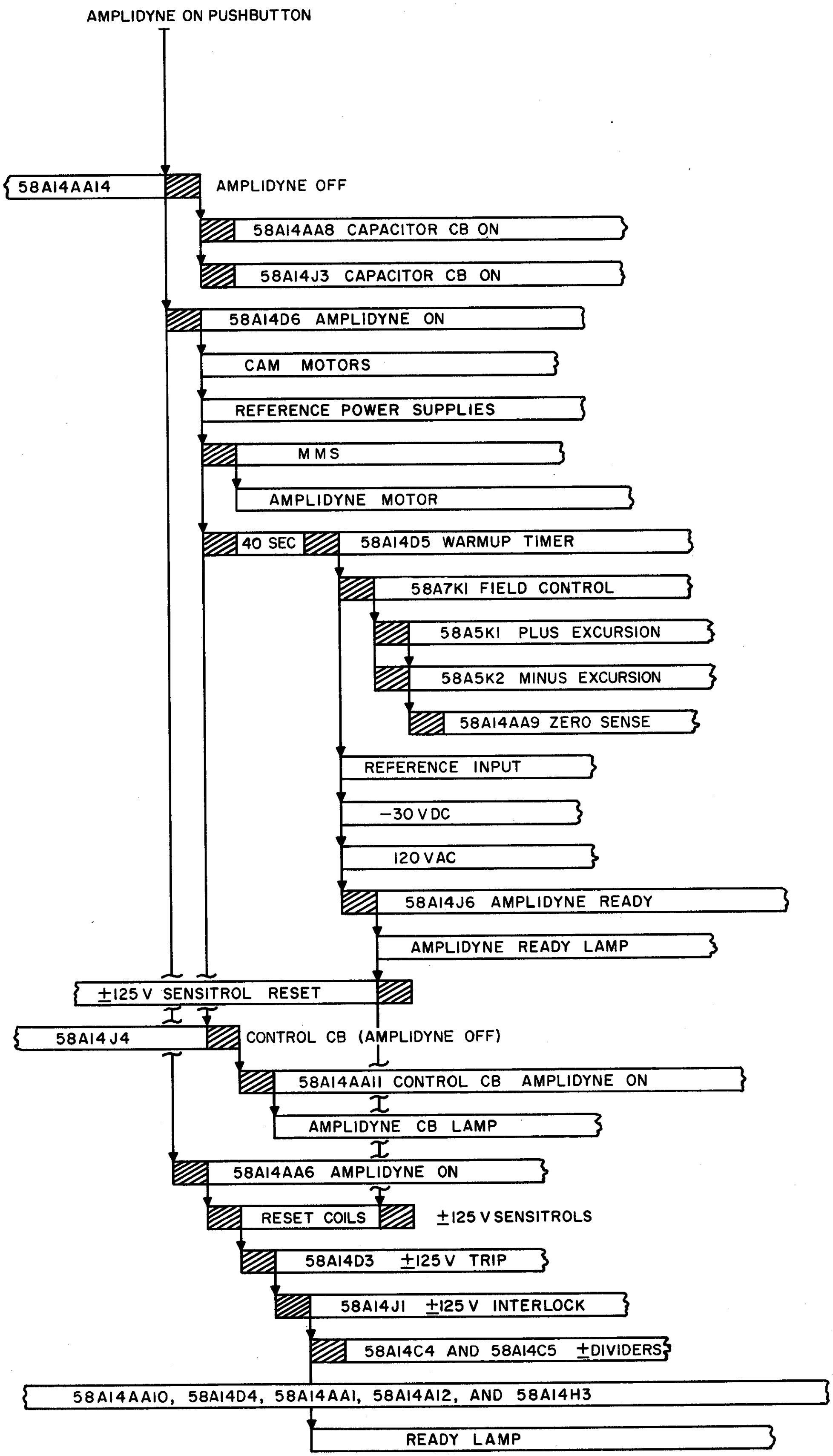


Figure 4–8. Simplex Amplidyne-Start Sequence, Simplified Sequence Chart

a. Contacts 1a-1c close to form a hold circuit for both amplidyne-on relays when the START AMPLIDYNE pushbutton is released.

b. Contacts 2a-2b open to hold amplidyne-off relay 58A14AA14 de-energized.

c. Contacts 3a-3c close to condition the energizing circuit for excursion stop relay 58A14AA3.

d. Contacts 4a-4b open to de-energize the reset coil of the amplidyne control Sensitrol (S 5.5.9.1, sect. 3).

2.3.2 Amplidyne Motor and Magnetic Motor Starter

The magnetic motor starter is energized through contacts 10-11 of amplidyne-on relay 58A14D6 (S 5.5.1.1, sect. 9). The MMS for the simplex amplidyne operates in the same manner as the MMS for the duplex amplidyne (par. 2.3.2, Part 3, Ch. 2, Sect. 2), except that the AUX 1 contacts and the warmup timer of the simplex MMS energize field-control relay 58A7(K1).

2.3.3 Cam Motors

The cam motors are started when contacts 7-8 and 4-5 of amplidyne-start relay 58A14D6 close to complete the 120Vac circuit to the motors (S 5.5.2.3). The cam units are not coupled to the motors until an excursion sequence is initiated.

2.3.4 Reference-Voltage Power Supplies

The reference-voltage power supplies are energized through contacts 7-8 and 4-5 of relay 58A14D6. The reference-voltage power supplies are given 40 seconds to warmup before the output voltage monitors are activated. The moving contacts of the voltage monitors are held in the central position by the reset coils. These coils are de-energized when amplidyne-ready relay 58A14J6 is energized and its contacts 2a-2b open. Relay 58A14J6 is energized through contacts 6a-6c of field-control relay 58A7(K1) and 5a-5c of control-CB relay 58A14AA11. The field-control relay is energized when the warmup timer expires.

2.3.5 Field-Control Relay

The field-control relay controls the inputs to the field-control chassis. Field-control relay 58A7(K1) is energized 40 seconds after the MMS is energized. This delay permits the amplidyne motor to come up to speed, and the reference-voltage power supplies to stabilize before the field-control chassis begins to function.

When contacts 5-7 of the warmup timer close (40 seconds after the MMS is energized), —48Vdc is applied to the field-control relay through contacts 1-3 of AUX 1 of the MMS (S 5.5.1.1, sect. 9); the warmup-timer contacts; and auxiliary contacts of CB's 58A7(CB1), 58A7(CB2) 58A7(CB3), and 58A7(CB4).

When relay 58A7(K1) is energized, the following actions occur:

a. Contacts 6a-6c close to complete the circuit to amplidyne-ready relay 58A14J6 (S 5.5.1.1, sect. 9).

b. Contacts 5a-5c close to connect the —30Vdc bias source to the field-control chassis (S 5.5.9.1, sect. 10).

c. Contacts 4a-4c close to connect the reference-input voltage to the control chassis.

d. Contacts C1-C2 close to connect regulated 120Vac to the control chassis.

The contacts of relay 58A14J6 perform the following functions:

a. Contacts 3a-3c close to light the AMPLIDYNE READY lamp (S 5.5.11.1, sect. 7).

b. Contacts 2a-2b open to de-energize the reset coils of the ±125Vdc Sensitrols (S 5.5.8.1, sect. 10).

2.3.6 Zero-Sense Relay

Zero-sense relay 58A14AA9 conditions the cam-start circuits. The zero-sense relay is energized by contacts 1a-1c of both minus-excursion relay 58A5(K2) and plus-excursion relay 58A5(K1). Since either the plus- or minus-excursion relay is de-energized when the amplidyne output is greater than ±0.75V, the zero-sense relay is energized only when the amplidyne output is less than ±0.75V (par. 1.4, Part 2).

When relay 58A14AA9 is energized, contacts 1a-1c close to condition the —48Vdc circuit to cam-clutch relay 58A9 (S 5.5.1.1, sect. 5).

2.3.7 Plus- and Minus-Divider Relays

The plus- and minus-divider relays remove the reference-input voltage from the amplidyne if there is an open circuit in the reference-input voltage-divider network.

When ±125V interlock relay 58A14J1 (S 5.5.8.1, sect. 10) is energized through contacts 5-7 of ±125V Sensitrol-trip relay 58A14D3, its contacts 5a-5c close to energize divider-plus relay 58A14C4, and its contacts 6a-6c close to energize divider-minus relay 58A14C5 (S 5.5.8.1, sect. 7). Contacts 5-7 of each divider relay close to condition the pick circuit of reference-input relay 58A14J2.

2.3.8 Amplidyne Output Interlock

The amplidyne-output-interlock circuit is energized when —48Vdc is applied to the system. This circuit ensures that the amplidyne is not supplying an abnormal voltage. With no excursion applied, the amplidyne output should be 0V. When power is applied, —48Vdc energizes relay 58A14D4. Assuming that the amplidyne output is zero, the movable arm of the

amplidyne output voltage monitor will not make contact and relay 58A14D4 will be energized. Contacts 5-7 of relay 58A14D4 complete the pick circuit to amplidyne-output-interlock relay 58A14H3. Contacts of this relay perform the following functions:

a. Contacts 5a-5c close to condition the energizing circuit of reference-input relay 58A14J2.

b. Contacts 3a-3c close to complete the energizing circuit to DC and MC CB interlock relay 58B6G4 (S 5.4.10.2, sect. 4), and to illuminate the UNIT 58 MC CB lamp (S 5.5.11.1, sect. 11).

c. Contacts 3a-3b open to extinguish the AMPLIDYNE SENSITROL lamp (S 5.5.11.1, sect. 10).

d. Contacts 2a-2c open to condition the excursion-stop circuits (S 5.5.1.1, sect. 3).

When DC and MC CB interlock relay 58B6G4 is energized, its contacts close to complete the circuit to the d-c service-voltage relay associated with the standby power system. Contacts of the d-c service voltage relay connect the MC voltages to the voltage contactors in unit 58 (par. 2.5.10.5, Part 2, Ch. 2).

2.3.9 Indicators

A start-amplidyne sequence results in the illumination of the following indicators on the MC control panel (S 5.5.11.1):

a. UNIT 58 MC CB

b. CONTROL CB

c. AMPLIDYNE READY

d. READY

The UNIT 58 MC CB lamp is illuminated through contacts 3a-3c of amplidyne-output-interlock relay 58A14H3 and auxiliary contacts of the d-c and MC CB's. This light will remain illuminated unless a CB is opened or the amplidyne-control Sensitrol (S 5.5.9.1) is pinned by an abnormal amplidyne output voltage.

The CONTROL CB lamp is illuminated through contacts 1a-1c of control-CB (amplidyne-on) relay 58A14AA11. This light will remain illuminated as long as the relay remains energized.

The AMPLIDYNE READY lamp is illuminated through contacts 3a-3b of control-CB (amplidyne-off) relay 58A14J4, contacts 3a-3c of amplidyne-ready relay 58A14J6, and contacts 4a-4c of capacitor CB on relay 58A14AA8. The lamp will remain illuminated whenever these relays are energized.

The READY lamp indicated that the MC system is fully prepared to initiate an excursion and begin testing. This lamp is illuminated through contacts 3a-3b of control-CB (amplidyne-off) relay 58A14J4, contacts 3a-3c of amplidyne-ready relay 58A14J6, contacts 3a-3b of excursion-on-delay relay 58A14AA5, contacts 5a-5c of capacitor-CB-on relay 58A14AA8, contacts 2a-2c of ±125V interlock relay 58A14J1, contacts 4a-4c of control-CB (amplidyne-on) relay 58A14AA11, and contacts 4a-4c of no-two interlock relay 58A14AA10. This lamp is illuminated as long as the MC system is prepared to begin testing, and no excursion is applied to the load circuits. When an excursion is applied, this lamp is extinguished and the EXCURSION ON lamp is illuminated.

SECTION 3
SIMPLEX CALCULATOR MODE EXCURSION SEQUENCES

3.1 INTRODUCTION

This section discusses the circuits employed in the selection, application, and control of an excursion during simplex calculator-mode operations. An excursion sequence consists of the following functions:

a. Starting the excursion
b. Selecting the equipment to be tested
c. Controlling the amplidyne to obtain an excursion voltage and applying this excursion voltage to the selected equipment.
d. Allowing the selected circuits to perform their normal functions with an excursion applied
e. Returning the voltage on the line to normal when the excursion is completed
f. Disengaging the MC system from the selected equipment
g. Establishing the conditions that allow another excursion.

In the discussion of the various calculator-mode sequences, it is assumed that: (a) Power has been applied to the MC system and that all control- and service-voltage CB's are closed; (b) The amplidyne motor is running and the AMPLIDYNE READY lamp is lit; (c) The READY lamp is lit to indicate that the interlock circuits are engaged. Depressing the CALCULATOR mode pushbutton on the simplex maintenance console conditions these circuits before the excursion is started.

In the calculator mode, an excursion is initiated and controlled by circuits in the Central Computer. Therefore, to operate the simplex MC system in the calculator mode, the duplex MC system must be operating. Refer to Part 3 for a discussion of the duplex MC system.

When the CALCULATOR pushbutton is depressed, calculator-mode relays 58A14C6 and 58A14J8 are energized through contacts 3a-3c of the pushbutton (S 5.5.5.1). Contacts of relay 58A14C6 perform the following functions:

a. Contacts 12-13 open to disconnect the START EXCURSION pushbutton from the energizing circuit of cam-start relay 58A14AA2 (S 5.5.1.1, sect. 4). This action renders the pushbutton inoperative.
b. Contacts 7-8 close to condition the energizing circuit of simplex excursion-stop relay 58A14BB1 (S 5.5.4.1, sect. 13).
c. Contacts 10-11 close to condition calculator-mode relay 58A14BB22. This relay is energized after the excursion cycle begins.

The contacts of relay 63A14J8 perform the following functions:

a. Contacts 5a-5c close to connect the reference-input voltage to the voltage-divider network (S 5.5.8.1, sect. 5).
b. Contacts 2a-2c and 4a-4c connect the 125V reference voltages to the safe-limit-select circuit.

3.2 EXCURSION-START SEQUENCE

An excursion sequence is started when cam units 58A9 and 58A10 are coupled to the cam motors (fig. 4–9, foldout). Coupling occurs when the associated cam clutches are energized. The clutch of cam unit 58A9 is energized through contacts of 58A9(C14), contacts 1a-1c of zero-sense relay 58A14AA9, and contacts 3a-3c of cam-start relay 58A14J5 (S 5.5.1.1, sect. 5). The zero-sense relay is energized during the start-amplidyne sequence (par. 2.3.6) and the cam contacts are closed at the cam-latch point of 245 degrees. Therefore, an excursion will start when relay 58A14J5 is energized.

Cam-start relays 58A14J5 and 58A14AA2 are energized by control relays under control of programmed instructions from the Central Computer. The energizing circuits for these control relays are conditioned during the start-amplidyne sequence. The circuits are completed when start relay 58A14BB2 is energized by *Operate* instructions from the Central Computer. Relays 58A14J5 and 58A14AA2 are energized through contacts 4a-4c of relay 58A14BB2, which is energized by a 1 in the left-sign bit of the control word after a *PER 21* instruction is executed.

Note

The same *PER 21* instruction that results in energizing 58A14BB2 also conditions the RYD's in the test register to transfer MC instructions and control data to the calculator-control relays (0.1.3).

3.3 SELECTING EQUIPMENT FOR TESTING

The first process controlled by the cams is the selection of the equipment to be marginally checked.

To check simplex equipment in the calculator mode, both the simplex and duplex MC systems must be operating. Since the status of the MC relays determines the type of voltage (MC or non-MC) supplied to the load circuits, the process must result in energizing those MC relays that will distribute an MC voltage to the simplex channels in the standby-MC status.

3.3.1 Simplex Equipment-Group Selection

Selection of the simplex equipment group (group 9) limits the application of an excursion to simplex equipment. In calculator mode, simplex equipment is selected when the MC-control word has the configuration 1001 in bits RS to R3, respectively.

3.3.1.1 Selection Circuit

In order to select simplex equipment for marginal checking, both the duplex and the simplex MC systems must be operating, and the CALCULATOR mode pushbuttons on both duplex and simplex maintenance consoles must be depressed.

The relays that limit the MC test to simplex equipment are picked when cam C1 of cam unit 63A9 closes its contacts to complete the circuit conditioned by the relays associated with bits RS through R3 of the MC control word.

When the calculator mode is selected, contacts 2a-2c of duplex-calculator-mode relay 63A14Y23 close. The simplex MC group is now selected by the calculator-controlled relays assigned to equipment group selection. A calculator-controlled relay is energized if the associated RYD in the Central Computer is energized by a 1 in the corresponding bit position of the MC-control word in the test register. The bit configuration for a simplex selection is 1001 in bits RS through R3, respectively. When the relays associated with bits RS and R3 (63A14BB19 and 63A14BB22, respectively) are energized and cam unit 63A9 is rotated, simplex relays 63A14CC1 through 63A14CC6 and relay 63A14Y22 are energized through contacts of cam 63A9(C1), contacts 2a-2c of relay 63A14Y23, contacts 1a-1c of relay 63A14BB19, contacts 2a-2b of relay 63A14BB20, contacts 3a-3b of relay 63A14BB21, and contacts 5a-5c of relay 63A14BB22.

3.3.1.2 Function of Simplex Equipment-Group Relays

Simplex equipment-group relays 63A14CC1, 63A14-CC2, 63A14CC3, 63A14CC4, 63A14CC5, 63A14CC6, and 63A14Y22 condition the circuit-group-select circuits.

3.3.2 Voltage-Group Selection

The voltage-group selection limits the application of the MC excursion to a specific voltage within the simplex-MC group. The voltage-group selection is performed by the voltage relays and the voltage contactors. The function of limiting the distribution of the MC voltage is performed by the voltage-selection circuit and contacts of the simplex-group relays.

3.3.2.1 Selection Circuit

The voltage relays are conditioned when duplex cam 63A9(C21) closes its contacts at 45 degrees of cam rotation. At this time, voltage relays 58A14BB16, 58A14BB17, and 58A14BB18 may be energized through contacts of the simplex-group relays, contacts of duplex-voltage-group relays 63A14BB16, 63A14BB17, and 63A14BB18, and contacts of the appropriate standby-computer relay (S 5.5.4.1). Duplex voltage relays 63A14BB16, 63A14BB17, and 63A14BB18 are controlled by the RYD's associated with bits L13, L14, and L15, respectively, of the MC-control word. Consequently, the simplex-voltage relays 58A14BB16, 58A14-BB17, and 58A14BB18 are controlled by the same bits. If only bit L15 contains a 1 (typical +250V selection), relay 63A14BB18 will be energized and its contacts 5a-5c will provide an energizing circuit for relay 58A14BB18 S 5.5.4.1, sect. 6). Contacts 2a-2c of relay 58A14BB18 will close to complete the energizing circuit to +250V voltage-contactor relays 58A14Z13 and 58A14Z14 (S 5.5.3.2).

3.3.2.2 Functions of the Selected Voltage Relays

When typical voltage-contactor relay 58A14Z13 is energized, contacts 4a-4c complete the circuit to the transfer coil of the +250V contactor 58A12B (S 5.5.10.1) and remove power from the back coil of the contactor. Power is still applied to the back coils of the unselected voltage contactors to prevent them from energizing.

3.3.3 Circuit Group Selection

Simplex circuit-group selection is determined by relays 58A14Z1 through 58A14Z12. These relays are controlled by duplex relays 63A14AA19 through 63A14AA24 and 63A14Z6 through 63A14Z1, respectively. Relays 63A14AA19 through 63A14AA24 are controlled by bits R4 through R9, respectively; relays 63A14Z6 through 63A14Z1 are controlled by bits R10 through R15, respectively. Each simplex relay controls a separate set of circuit-group relays. This arrangement permits more than one circuit group to be selected at any one time.

3.3.3.1 Selection Circuit

Assuming that circuit B is selected (a 1 in bit R5 of the MC-control word), relay 63A14AA20 is energized (5.5.4.1). Contacts 2a-2c of this relay close to complete the circuit to relay 58A14Z2 (S 5.5.4.1, sect. 4). Contacts 1a-1c of relay 58A14Z2 close to energize relays 58A14X4 and 58A14X5 (S 5.5.3.1, sect. 6).

3.3.3.2 Functions of Circuit-Group Relays

The contacts of the selected circuit-group relays condition the pick circuit of the MC relay. When circuit-group-B relay 58A14X5 is energized, its contacts 1a-1c close to energize MC relay 58C6C2 (S 5.5.7.1). Other contacts of 58A14X5 will close, but no other MC relays will be energized because these contacts are not in the +250V select circuit. Contacts 2a-2c of relay 58A14X5 close to energize +0V safe-limit relay 58A14K4. The negative safe-limit (−100V) relay 58A14K9 is energized through contacts 3a-3c of +250V relay 58A14Z13 (S 5.5.6.1).

When relay 58A14K4 is energized, its contacts perform the following functions:

a. Contacts 2a-2c close to connect the reference-input voltage to the safe-limit point of the voltage-divider network (S 5.5.8.1, sect. 6).
b. Contacts 3a-3c open in the safe-limit select circuit (S 5.5.8.1, sect. 9).
c. Contacts 6a-6c close to connect the amplidyne output to the amplidyne-control Sensitrol (S 5.5.9.1, sect. 3).

When relay 58A14K9 is energized, its contacts perform the following functions:

a. Contacts 2a-2c close to connect the reference-input voltage to the −100V safe-limit point of the voltage-divider network (S 5.5.8.1, sect. 6).
b. Contacts 3a-3c close in the safe-limit select circuit (S 5.5.8.1, sect. 9).
c. Contacts 5a-5c close to connect amplidyne neutral to the resistor network of the amplidyne-control Sensitrol (S 5.5.9.1, sect. 3).

3.3.4 UNIT STATUS Switch

Marginal checking is performed on a channel when the UNIT STATUS switch associated with that channel is in the STANDBY MC position. While the MC test is in progress, the power status of the channel cannot be changed until the excursion-on relays are de-energized.

3.3.4.1 Status Selection

To reach the standby MC status (S 5.4.10.3, sheet 9), the d-c contactor relays K3 and K2 (for power system C) or K10 and K11 (for power system D) are not energized, as wafer B of the UNIT STATUS switch has no connection for position 4. After K1 (for power system C) or K12 (for power system D) is energized, K8 and K13 are energized. The circuit for power system C is traced in table 4—2.

After K8 and K13 are energized through the circuit completed by position 4 on wafer D of the UNIT STATUS switch, contacts 5c-5a of K13 provide a hold circuit through contacts 1a-1c of an excursion-on (MC) relay (S 5.4.10.3, blocks 82 and 81). As long as the associated excursion-on relay is energized during marginal checking, K8 and K13 will remain energized.

Contacts 1a-1c of K8 provide a hold circuit for a-c contactor relay K1. Contacts 2a-2b prevent d-c control relay K4 from being energized. Contacts 3a-3c provide a circuit to energize low-voltage d-c contactor relay K3 through contacts 9a-9c of K1 after contacts 5a-5c of K16 are closed following the action of time-delay relay K7. Contacts 4a-4c of K8 provide a circuit

TABLE 4—2. CIRCUIT TO ENERGIZE RELAYS K8 AND K13

CONTACT OR TERMINAL	COMPONENT	BLOCK NO. ON S 5.4.10.3
e	CB	33
d–b	D–C CB	29, 28, 27, 26, 25, 24, 23, 22
Terminal		18
Contacts	Control relay	17–16
Terminal		13
Terminal		20
Terminal		65
16	J3–P3	
10a–10c	K1	
10a	K12	
5c	K13	
48	P2B–J2B	
Terminal		64
A17	Connector	118
4	Unit status	
a	Wafer D	
A16	Connector	119
Terminal		83
Contacts	Control relay	79–80
Terminal		77
40	J2B–P2B	
4b–4a	K9	
4b–4a	K4	
Y	K8 and K13	

for contacts 8a-8c of K3 to energize high-voltage d-c contactor relay K2. These circuits all remain complete, regardless of the movement of the UNIT STATUS switch, until K8 and K13 are de-energized at the end of the MC test.

3.3.4.2 Functions of the UNIT STATUS Switch

The STANDBY MC position of the UNIT STATUS switch serves two functions: It provides for the selection of individual channels to be tested by marginal checking, and it prevents selected channels from being deselected during MC operations.

3.4 NO-TWO INTERLOCK CIRCUIT

The simplex no-two interlock circuit prevents the selection of more than one mode operation or voltage group. No-two interlock relay 58A14AA10 is energized through normally closed contacts of the mode-selection relays and the voltage-group-selection relays (S 5.5.1.1, sect. 1). The energizing circuit is arranged so that the relay will be energized before an excursion is started only if one mode-selection relay and one voltage-group selection relay is energized. If a second voltage-group or mode-selection relay is energized, the no-two interlock relay will be de-energized. For the detailed operation of this interlock circuit, refer to Section 4.

3.5 EXCURSION CONTROL

An excursion is controlled by varying the current in the amplidyne-field winding. Figure 3–9 is a simplified block diagram of the circuits used to control an excursion. The reference-voltage power supplies are the sources of the amplidyne input. The reference voltage is applied across a voltage-divider network which limits the amplidyne output to the safe limit of the circuit to be tested. In the calculator mode, the voltage-divider network also selects the magnitude of the excursion voltage.

The field-control chassis receives the reference-input voltage and controls the amplidyne so that the amplidyne output is proportional to the reference input. The output voltage of the amplidyne is connected to the selected voltage line through the voltage contactor. The resulting voltage (line voltage plus amplidyne output voltage) is applied to the selected circuits in the load units through the MC relays.

3.5.1 Reference Voltage Power Supply Output

The 125Vdc outputs from the reference-voltage power supplies are connected to the voltage-divider network through contacts of relay 58A14J1. The +125Vdc output is connected through contacts 5a-5c of this relay; the −125Vdc output is connected through contacts 6a-6c (S 5.5.8.1, sect. 9).

3.5.2 Reference Input Selection

The 125Vdc reference-input voltage is connected to the amplidyne-control circuits through contacts 3a-3c of relay 58A14J2 (S 5.5.8.1, sect. 4). Contacts 5a-5c of calculator-mode relay 58A14J8 connect the output of the selected voltage divider to the reference-input line (S 5.5.8.1, sect. 5).

The reference-input voltage is applied to the amplidyne-control circuit after the MC relays connect the MC-voltage line to the load circuits. The following conditions must exist before the energizing circuit for reference-input relay 58A14J2 is completed (S 5.5.1.1, sect. 2):

a. The output of each of the reference-voltage power supplies must be within 10 percent of the nominal 125Vdc. If either voltage is not within this limit, contacts 3a-3c of ±125Vdc interlock relay 58A14J1 open the energizing circuit to relay 58A14J2 (par. 2.5.10.3, Part 2, Ch 1).
b. The MC-control voltage CB's must be closed. Control-CB (amplidyne-on) relay 58A14AA11 drops to open the energizing circuit to 58A14J2 if a CB is opened (par. 2.2.2 and 2.3.1, sect 2).
c. Excursion-on relay 58A14AA4 must be energized.
d. The voltage-divider networks in the reference-input circuitry must be connected to the reference-voltage power supplies as outputs. The divider relays (plus, minus, and calculator) drop if an open circuit occurs in the divider-relay interlock circuit (par. 1.5.10.2, Part 2 Ch 1). The energizing circuit to the reference-input relay is opened if any one of the divider relays is de-energized.
e. The amplidyne-output circuits must be functioning properly. Amplidyne-output-interlock relay 58A14H3 is energized unless an abnormal voltage condition is detected. If an abnormal voltage condition is detected, contacts 5a-5c of relay 58A14H3 open the energizing circuit to relay 58A14J2 (par. 2.5.10.4, Part 2, Ch 1).

If any of the above circuits fail to function properly, reference-input relay 58A14J2 will be de-energized and its contacts 3a-3b will connect the reference-input voltage to the voltage level of amplidyne neutral.

3.5.3 Safe-Limit Selection

The safe-limit selection protects the circuits being tested from damage by excessive voltage. The safe-limit selection is made at the voltage-divider network in the reference input circuitry.

3.5.3.1 Divider Network

The voltage applied to the divider network is determined by safe-limit selection relays 58A14K1,

58A14K3 through 58A14K6, 58A14K9, and 58A14J9 (S 5.5.8.1, sect. 9). These relays are energized through contacts of the safe-limit-select circuit (S 5.5.6.1). The reference-input voltage is applied to the divider network through the contacts of the safe-limit-select relays and a variable resistor. The variable resistor drops the 125Vdc input to the level of the selected safe limit.

3.5.3.2 Safe-Limit-Selection Circuit

A maximum safe limit is assigned to each excursion voltage to prevent the MC test voltage from damaging the selected circuits. Safe limits of +0, +25, +75, +100, —0, and —100 volts may be selected.

The amount of voltage variation that a circuit will withstand before being damaged depends on the type of circuit and its application. Similar circuits may withstand different voltage variations, depending upon the particular application of the circuit. Therefore, the safe limit for an excursion voltage is determined by the voltage-group/circuit-group selection made.

A safe-limit selection consists of energizing two safe-limit relays. These relays establish the highest and the lowest excursion voltage that can be applied to the circuit.

A relay matrix (S 5.5.6.1) determines which safe-limit relays are energized for a particular excursion. This matrix is composed of contacts of the voltage-group and circuit-group relays. Contacts of the voltage-group relay close to condition two matrices. One matrix conditions a circuit to energize an upper safe-limit relay. The other matrix conditions a circuit to a lower safe-limit relay. The circuits through both matrices are completed by contacts of the circuit-group relays.

In certain voltage-group selections, power is applied directly to the safe-limit relays without passing through a relay matrix. This arrangement is used when all the circuits serviced by a voltage have the same safe limit. For example, all circuits serviced by the +90Vdc line will withstand a —100V excursion. Therefore, the —100V safe-limit relay is energized directly through contacts of the +90Vdc voltage-group relay.

3.5.4 Excursion Polarity Control

The polarity of an excursion is determined by the polarity of the reference voltage applied to the amplidyne-field winding through the voltage-divider network. The polarity of the reference-input voltage is determined by bit L7 of the MC-control word. If bit L7 contains a 0, the polarity is positive. If bit L7 contains a 1, the polarity is negative.

When bit L7 contains a 1, duplex-minus-polarity relay 63A14BB10 is energized. The duplex relay is energized by the associated RYD through cam 63A10-(C1) and contacts of relay 63A14C6. Contacts 2a-2c of relay 63A14BB10 close to condition the energizing circuit to relay 58A14BB10. The simplex relay is energized when cam 63A10(C4) closes its contacts at 40 degrees of cam rotation.

When relay 58A14BB10 is energized its contacts 1a-1c close to energize minus polarity relays 58A14H1 and 58A14H2. Contacts of these relays perform the following functions:

a. Contacts 2a-2c of relay 58A14H1 and 4a-4c of relay 58A14H2 close to connect the —125Vdc reference-power supply to the safe-limit-select circuits (S 5.5.8.1, sect. 9).
b. Contacts 2a-2c of relay 58A14H1 open to disconnect the +125Vdc reference-power supply from the safe-limit-select circuit (S 5.5.8.1, sect. 9).
c. Contacts 3a-3c of relay 58A14H1 connect amplidyne neutral to the reference input if a zero-volt safe limit is selected (S 5.5.8.1, sect. 5).
d. Contacts 2a-2c, 3a-3c, and 5a-5c of relay 58A14H2 close to complete the energizing circuit between the excursion relays and the negative safe-limit relays (S 5.5.8.2).

3.5.5 Excursion Magnitude Control

The excursion voltage varies with the reference-input voltage to the amplidyne. The magnitude of the excursion voltage is controlled by bits in the MC word.

In the calculator mode, the excursion voltage is determined by the point in the voltage divider selected as the output. There are 16-positive- and 16-negative-excurson voltages ranging from 0 to 100V.

The selection of an excursion voltage is controlled by bits L9 through L12 in the control word. The RYD's associated with these bits control duplex relays 63A14BB11 through 63A14BB14. These relays are energized when calculator-mode relay 63A14C6 is energized (5.5.4.1, sect. 11). Contacts of relays 63A14BB11 through 63A14BB14 close to complete the energizing circuits to simplex relays 58A14BB11 through 58A14-BB14 after an excursion is begun (S 5.5.4.1, sects. 9 and 10).

If the configuration of bits L9 through L12 were 0100, only relay 58A14BB12 would be energized. Contacts 1a-1c of relay 58A14BB12 close to energize 16V-excursion relay 58A14F8 (S 5.5.4.1, sect. 4). Contacts 2a-2c of relay 58A14F8 close to connect the 16V tap of the voltage divider network to the calculator-mode reference-input-voltage line (S 5.5.8.1, sect. 7).

3.5.6 Applying The Excursion

The excursion voltage generated by the amplidyne is connected to the selected voltage line by the voltage contactors in the MC unit. The MC-test voltage is connected to the selected MC relays in the same unit. The MC relays are transferred before the voltage is varied.

This paragraph describes the application of the voltage through the voltage contactors and the MC relays. The method of selecting the voltage contactors and MC relays is described in paragraphs 3.3.2 and 3.3.1, respectively.

3.5.6.1 Voltage Contactors

The voltage contactors connect the amplidyne output in series with the MC voltage from the PCD unit. If MC operations are not in progress, the MC voltages are fed from the PCD unit to the load units through unit 55.

3.5.6.2 MC Relays

The contacts of the MC relays distribute all voltages that may be selected for marginal checking. When the circuit serviced by a particular MC relay is not selected for marginal checking, the MC relay is de-energized and the contacts distribute non-MC voltage to the load units. The circuit-selection sequence energizes particular MC relays, and the MC-relays contacts transfer. Therefore, when a circuit is selected for marginal checking, the associated MC relay is energized and the contacts distribute the MC-test voltage to the selected load unit.

3.5.7 Excursion Duration Control

The duration of an excursion must be long enough to permit the circuits to perform normal operations while the abnormal voltage is applied.

In the calculator mode, an excursion may be 3, 7, or 30 seconds, or infinite in duration. Electromechanical-timing-relays control the excursion duration. Each timer relay consists of three cam-control assemblies and a motor. The contacts of the relay are opened and closed by the cams. The motor is actuated at the beginning of an excursion. After a preset time delay, the cams have rotated to close the contacts which complete a stop-excursion circuit.

Two of the three cam assemblies in each timer close contacts in the stop-excursion circuit. The third assembly closes contacts in the circuit that resets the timer. The two contacts used in the stop-excursion circuit are set to close at different time intervals. The use of two timing relays therefore provides for four excursion durations. However, the duration-selection circuit provides for use of only the three finite time durations. The 3- and 7-second excursions are provided by timer 58A14C1; the 30-second excursion is provided by timer 58A14C2.

The duration of the excursion is determined by bits L5 and L6 of the MC control word. The RYD's associated with these bits control duplex relays 63A14BB8 and 63A14BB9. These duplex relays, in turn, control simplex excursion-duration relays 58A14BB8 and 58A14BB9. The contacts of the simplex relays form a matrix which selects the proper timer-control assembly (S 5.5.1.2). For example, assume that only bit L6 contains a 1 (3-second duration). Relay 63A14BB9 is energized through contacts 7-8 of relay 63A14C6 and cam 63A9(C1). Contacts 4a-4c of relay 63A14BB9 close to complete the circuit to relay 58A14BB9 (S 5.5.4.1, sects. 8 and 9). Contacts 5a-5c of relay 58A14BB9 close to complete the circuit to duration relay 58A14G3 (S 5.5.1.2, sect. 9). Excursion-duration timers 58A14C1 and 58A14C2 are energized through closed contacts 3a-3c and 5a-5c of this relay (S 5.5.2.3). Both excursion-duration timers are energized, but only the contacts which correspond to the desired duration stop the excursion. When excursion-duration timer 58A14C1 closes its contacts 2a-2c, the circuit to duration-stop relay 58A14AA13 is completed.

Note

Contacts 2a-2c of timer 58A14C1 close after 3 seconds. If a 7-second duration were selected, contacts 2a-2c of relay 58A14BB8 would be closed and the energizing path for relay 58A14AA13 would be across contacts 1a-1c of timer 63A14C1 (S 5.5.1.2). A similar energizing path for a 30-second duration requires relays 58A14BB8, 58A14BB9, and timer 58A14C2 to operate.

3.5.8 Duration Stop

A duration-stop sequence is initiated when contacts of the excursion-duration timer close to complete the energizing circuit to duration-stop relay 58A14AA13. The contacts of this relay perform the following functions:

a. Contacts 5a-5c close to energize excursion-stop relay 58A14AA3 (S 5.5.1.1, sect. 3).
b. Contacts 2a-2c close to energize cam-clutch relay 58A10B through cam 58A10(C8). This action permits cam 58A10 to function during the excursion-stop sequence (S 5.5.1.2, sect. 11).
c. Contacts 1a-1c close to complete a hold circuit for the duration-stop relay (S 5.5.1.2, sect. 10).
d. Contacts 3a-3c close to condition the restart circuit (S 5.5.1.2, sect. 7).

3.6 CHANGE EXCURSION SEQUENCE

A change-excursion sequence affects only the magnitude, polarity, or duration of the excursion voltage, it does not affect the voltage or circuit previously selected by a start-excursion sequence. A change-excursion sequence is initiated by an MC-test word with a 0 in the left-sign bit. When an *Operate 21* instruction is given and the left-sign bit of the MC word is 0, the following actions occur:

a. A hold circuit is established for the relays which select the voltage and circuit to be tested.

b. The relays which control the magnitude, duration, and polarity of the excursion are de-energized and other magnitude, duration, and polarity relays, as indicated in the MC-control word, are selected.

An *Operate 21* instruction from the Central Computer energizes duplex *PER 21* relay 63A14BB2 (5.5.4.1, sect. 1). If the left-sign bit is 0, then the associated RYD and relay 63A14BB3 are not energized. Contacts 3a-3b of relay 63A14BB3 remain closed to maintain a pick path for simplex change-excursion relay 58A14BB3. Contacts of relay 58A14BB3 perform the following functions:

a. Contacts 1a-1c close to energize cam clutch 58A10B (S 5.5.1.2, sect. 11).
b. Contacts 6a-6c close to condition-duration relay 58A14G3 (S 5.5.1.2, sect. 9).
c. De-energize the relays that control the selection of an excursion and reselect excursion relays according to the new MC word. This action is accomplished by rotating cam unit 58A10.

3.7 STOP-EXCURSION SEQUENCE

A stop-excursion sequence returns the excursion voltage to zero and deselects the equipment that has been marginally checked. The excursion voltage is returned to zero by connecting the amplidyne-reference input to amplidyne neutral. The deselection process is accomplished by rotating both the cam units to open the hold circuits of the selection relays.

For purposes of explanation, it will be assumed that the calculator-controlled tests have been completed on the simplex +250V voltage group and circuit group B, and that this selection had a —16V excursion. This selection is essentially the same as that discussed in paragraphs 3.4 and 3.5.

In the calculator mode, the stop-excursion sequence is initiated by energizing stop-excursion relay 58A14AA3 (S 5.5.1.1, sect. 3).

3.7.1 Initiating the Stop-Excursion Sequence

In the calculator mode, a stop-excursion sequence (fig. 4—10) is normally initiated by a *Stop Excursion (PER 23)* instruction from the Central Computer. This instruction energized stop-excursion relay 58A14BB1 directly through the RYD's; the comparable duplex relay is not energized. Contacts 5a-5c of relay 58A14BB1 close to energize relay 58A14AA3 (S 5.5.1.1, sect. 3). The various circuits affected by the contacts of relays 58A14BB1 and 58A14AA3 are discussed below.

3.7.2 Returning the Excursion Voltage to Zero

Energizing relay 58A14AA3 causes the excursion voltage to go to zero. Contacts 3a-3b of this relay open to de-energize excursion-on relay 58A14AA4 and start-excursion relay 58A14C7. Contacts 2a-2c of relay 58A14AA4 open to de-energize reference-input relay 58A14J2 (S 5.5.1.1, sect. 2). Contacts of relay 58A14J2 perform the following functions:

a. Contacts 3a-3b close to connect the amplidyne-reference input to amplidyne neutral (S 5.5.8.1, sect. 4).
b. Contacts 1a-1c open to extinguish the EXCURSION ON lamp at the maintenance console (S 5.5.11.1, sect. 11).

3.7.3 Deselecting Cam Unit 58A9

Energizing excursion-stop relay 58A14AA3 initiates a cam-unit deselection process. Contacts 2a-2c close to energize cam-start relay 58A14J5 (cam unit 58A9). Contacts 3a-3c of relay 58A14J5 close to energize cam clutch 58A9 when contacts 1a-1c of zero-sense relay 58A14AA9 close. The zero-sense relay is energized when the amplidyne output is less than 0.75V. This condition prevents the damage to the contacts of the MC relays which would result if the contacts were transferred with a voltage applied.

Energizing cam clutch 58A9 starts a cam-rotation cycle which opens the hold circuits for the selection relays. The relays de-energized by this cam-rotation cycle are discussed below.

3.7.3.1 Safe-Limit Deselection

Safe-limit relays 58A14K1, 58A14K3 through 58A14K6, 58A14K9, and 58A14J9 are de-energized when cam 58A9(C11) opens its contacts at 254 degrees of cam rotation (S 5.5.6.1). Dropping the safe-limit relays disconnects the reference-input voltage at the voltage-divider network in the input circuit (S 5.5.8.1). The previously selected safe-limit relays (58A14K4 and 58A14K9) are de-energized at this time. Contacts of these relays open to remove the reference-input voltage from the voltage-divider network.

3.7.3.2 MC Relay Deselection

The selected MC relays are de-energized when cams 58A9(C8), 58A9(C9), and 58A9(C10) open their contacts at 270 degrees of cam rotation (S 5.5.7.1). The excursion voltage is zero when these relays transfer (par. 3.7.3).

3.7.3.3 Mode Relay Deselection

Calculator-mode relay 58A14BB22 is de-energized when cam 58A9(C5) opens its contacts at 315 degrees of cam rotation (S 5.5.5.1). Calculator-mode relays 58A14C6 and 58A14J8 remain energized through the mechanically held contacts of the CALCULATOR mode-selector pushbutton. Relays 58A14J8 and 58A14C6 enable a subsequent excursion sequence to be initiated by the MC program in the Central Computer.

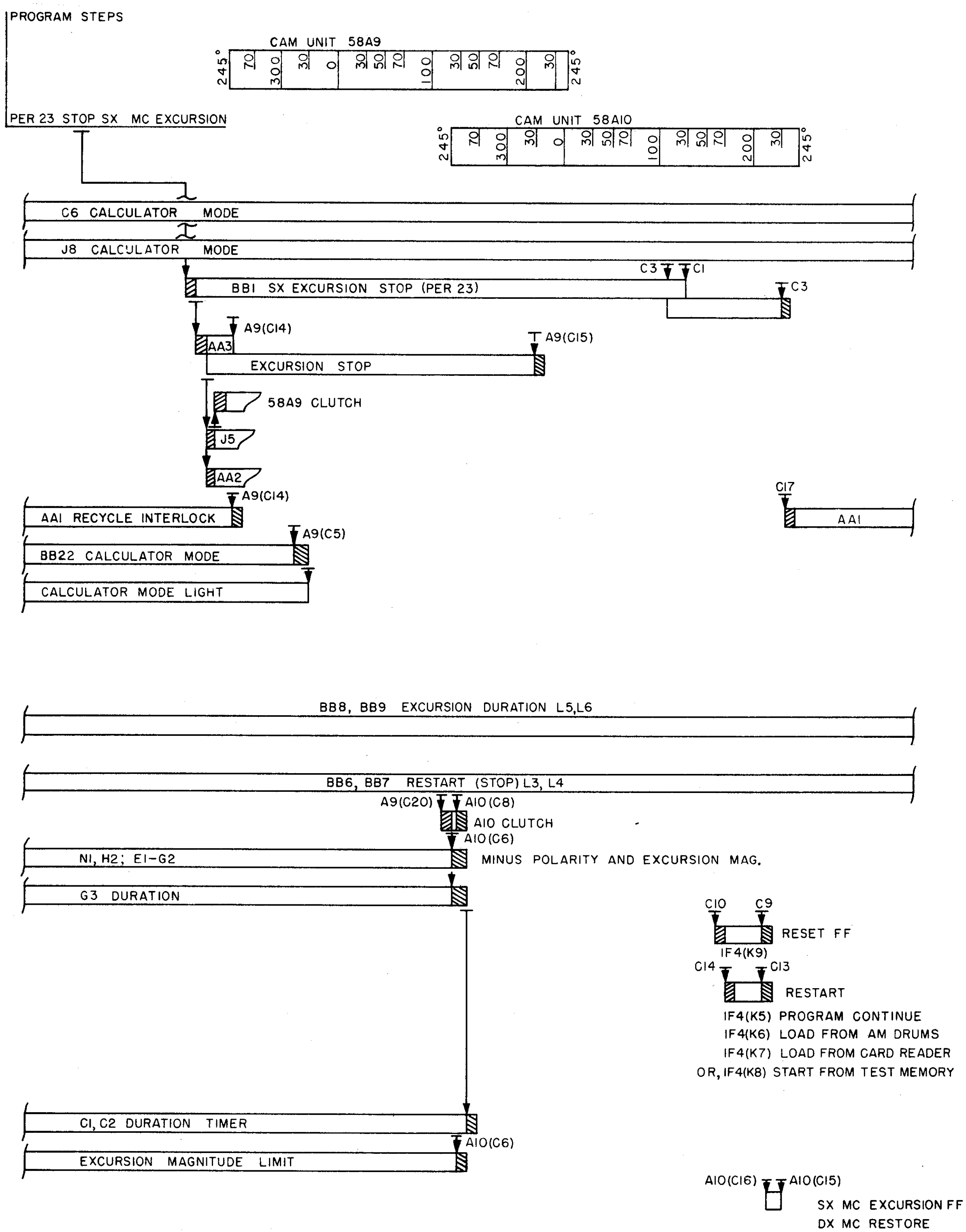


Figure 4–10. Simplex Stop-Excursion Sequence, Simplified Sequence Chart

3.7.3.4 Circuit-Group Relay Deselection

The selected circuit-group relays (58A14X4 and 58A14X5) drop when cam 58A9(C4) opens its contacts at 320 degrees of cam rotation.

3.7.3.5 Voltage Contactor Deselection

The transfer coil of the voltage contactor (58A12B) is de-energized when cam 58A9(C2) opens its contacts at 345 degrees of cam rotation (S 5.5.10.1). The back coils of the remaining voltage contactors are also de-energized and remain de-energized until the +250V voltage relay 58A14Z13 is de-energized when cam 58A9(C18) is opened at 360 degrees of cam rotation. After the contacts of the voltage relay transfer to the normally closed position, the contacts of cam 58A9(C2) close at 45 degrees and energize the back coil of each voltage contactor to prevent accidental transfer of the voltage-contactor contacts.

3.7.3.6 Voltage-Group Relay Deselection

The selected voltage-group relays are de-energized when cam 58A9(C18) opens its contacts at 360 degrees of cam rotation.

3.7.3.7 Simplex Equipment-Group Relay Deselection

The simplex equipment-group relays are de-energized when cam 63A9(C2) opens its contacts at 345 degrees of cam rotation (5.5.3.3).

3.7.3.8 Deselection of Calculator-Controlled Relays

The selection relays energized by the RYD's in the Central Computer are de-energized when the contacts of cam 58A9(C7) open at 215 degrees of cam rotation. The instruction- and excursion-control relays are dropped during the rotation cycle of cam unit 58A10.

3.7.4 Deselecting Cam Unit 58A10

A deselection sequence in the calculator mode requires a rotation of cam unit 58A10 to de-energize the calculator selection and control relays. This rotation is initiated when cam clutch 58A10B is energized through the contacts of cam 58A9(C20) (which close at 110 degrees of cam rotation), through contacts 2a-2c of stop-excursion relay 58A14BB1, and through closed contacts of cam 58A10(C8).

When cam unit 58A10 rotates, the hold circuits are opened for those selection relays used only in the calculator mode.

3.7.4.1 Excursion Duration Deselection

The duration of the excursion in calculator mode is controlled by excursion-duration timers 58A14C1 and 58A14C2. The duration timers are both energized through contacts 3a-3c and 5a-5c of relay 58A14G3. This relay is de-energized during the stop-excursion sequence when the contacts of cam 58A10C6) open at 250 degrees of cam rotation (S 5.5.1.2, sect. 9). This cam also controls the hold circuits of minus-polarity relays 58A14H1 and 58A14H2.

3.7.4.2 Excursion Polarity Deselection

When the minus-polarity relays are de-energized by cam 58A14(C6), the −125Vdc power supply is disconnected from the safe-limit select circuit.

3.7.4.3 Excursion Magnitude Deselection

The selected excursion-magnitude relay is de-energized when the contacts of cam 58A10(C2) open at 215 degrees of cam rotation (S 5.5.4.1, sects. 9-12). The contacts of the de-energized excursion relay open in the reference input circuit (S 5.5.8.1).

3.7.4.4 Calculator-Controlled Relay Deselection

The simplex calculator-controlled relays drop when the contacts of cam 63A10(C4) open at 115 degrees of cam rotation (S 5.5.4.10).

3.8 STOP AMPLIDYNE SEQUENCES

3.8.1 Stopping After an Excursion

Depressing the STOP AMPLIDYNE pushbutton initiates a sequence which de-energizes the MC system and leaves it in a power-on status. If the pushbutton is depressed when no excursion sequence is in progress, the pushbutton will open the circuit to amplidyne-on relays 58A14D6 and 58A14AA6 (S 5.5.1.1, sect. 7). De-energizing these relays causes all the circuits dependent upon these relays to be restored to the condition present before the amplidyne was energized (par. 2.3).

If the STOP AMPLIDYNE pushbutton is depressed during an excursion sequence, the amplidyne-stop interlock circuit prevents the amplidyne circuits from being energized until a stop-excursion sequence is completed.

3.8.2 Stopping During An Excursion

The amplidyne-stop interlock circuit functions when an attempt is made to de-energize the amplidyne during an excursion sequence. The contacts of the amplidyne-stop relay initiate a stop-excursion sequence and delay the de-energization of the amplidyne circuits until this stop-excursion sequence is initiated.

During an excursion sequence, the STOP-AMPLIDYNE pushbutton cannot cause the amplidyne-on relays to drop because these relays are held by contacts of excursion-on-delay relay 58A14AA5. Relay 58A14-AA5 is energized by controls 7-8 of start-excursion relay 58A14C7 and cam 58A9(C3). This alternate hold circuit prevents the amplidyne-on relays from dropping until the excursion-on delay relay is dropped during the deselection of cam unit 58A9.

If the STOP AMPLIDYNE pushbutton is depressed during an excursion, normally open contacts

2a-2c of the pushbutton close to complete the pick circuit to amplidyne-stop interlock relay 58A14AA7. This relay is also energized during an excursion sequence if the service- and capacitor-CB on relay drops as the result of an open CB. When relay 58A14AA7 is energized, its contacts perform the following functions:

a. Contacts 1a-1c and 2a-2c close to form a hold circuit for the relay through cam 58A9(C16). This cam does not make contact until 325 degrees of cam rotation. The hold circuit is maintained until that time by contacts 6a-6c of excursion-on delay relay 58A14AA5 which drops at 360 degrees of cam rotation. The hold circuit is maintained through cam 58A9(C16) until 240 degrees of cam rotation.

b. Contacts 5a-5c close to complete the energizing circuit to excursion-stop relay 58A14AA3 (S 5.5.1.1, sect. 3).

c. Contacts 4a-4c close to form a hold circuit for relay 58A14AA7 after the contacts of the excursion-on delay relay open (S 5.5.1.1, sect. 6). This hold circuit is through closed contacts 1a-1b and 2a-2b of the START AMPLIDYNE pushbutton and cam 58A9(C14). This circuit is significant only after the excursion-stop sequence is completed because the relay is held through alternate circuits until the cam cycle is completed. Therefore, the START AMPLIDYNE pushbutton is effective in opening a hold circuit to the amplidyne-stop interlock relay only after the excursion has been stopped.

SECTION 4
MANUAL MODE EXCURSION SEQUENCES

4.1 INTRODUCTION

This section discusses the circuits employed in the selection, application, and control of an excursion during the manual mode of operation. In the manual mode of operation, the specific operations of an excursion sequence are initiated and controlled by pushbuttons and switches on the simplex maintenance console rather than by the RYD's in the Central Computer that are conditioned by an MC control word.

Before excursion sequences can be initiated, the amplidyne and its associated circuitry must be operating and the simplex MC system must be receiving power. These conditions are fulfilled when the AMPLIDYNE READY lamp and the READY lamp on the simplex maintenance console are lit (par. 3.1).

After the above lamps are lit, the manual mode of operation is selected by depressing the MANUAL pushbutton on the maintenance console. Depressing this pushbutton conditions the energizing circuit for manual-mode relays 58A14BB19 and 58A14H4. These relays are not energized until after the EXCURSION START pushbutton is depressed and cam 58A9(C6) closes its contacts at 330 degrees of cam rotation (S 5.5.5.1).

When manual-mode relays 58A14BB19 and 58A-14H4 are energized, their contacts perform the following functions:

a. Contacts 5a-5c of 58A14H4 close to connect the output of the potentiometer at the MC-control panel to the reference-input circuit (S 5.5.8.1, sect. 5).
b. Contacts 2a-2c and 3a-3c of 58A14H4 close to connect the manual-mode divider network to the potentiometer (S 5.5.8.1, sect. 6).
c. Contacts 4a-4c of 58A14H4 close to condition the energizing circuit of reference-input relay 58A14J2 (5.5.1.1, sect. 1).
d. Contacts 3a-3c of 58A14BB19 close to condition the no-two interlock circuit so that a second mode cannot be made (S 5.5.1.3, sect. 1).
e. Contacts 2a-2c of 58A14BB19 close to illuminate the MANUAL mode light on the MC control panel (S 5.5.11.1, sect. 6).

4.2 SELECTING EQUIPMENT FOR TESTING

In the manual mode, the voltage and circuit group to be marginally checked must be designated by actuating the pushbuttons or switches associated with the desired selection. The simplex MC system is selected by energizing the amplidyne after power has been applied to the system. The other selection relays are energized when the START EXCURSION pushbutton is depressed. A typical selection, which is discussed below, is: +250V, circuit B. This is the same selection that was used to illustrate the calculator mode of control.

4.2.1 Voltage-Group Selection

A voltage group is selected by depressing the pushbutton associated with the desired voltage group. Only one voltage group may be selected at any one time. When the +250 (+250-voltage group) pushbutton is depressed, contacts 1a-1c of the pushbutton condition the energizing circuit of +250V relays 58A14Z13 and 58A14Z14 (S 5.5.3.2). These relays are not energized until an excursion is started and the contacts of cam 58A9(C3) close at 20 degrees of cam rotation (par. 3.3.2).

4.2.2 Circuit-Group Selection

A circuit group is selected by closing the switches associated with the desired circuit groups. Any number of circuit-group selections may be made simultaneously. If none are made, all circuits are automatically selected.

Assuming that only circuit-group B is selected, the energizing circuits of relays 58A14X4 and 58A14X5 are conditioned by contacts 3a-3c of the switch. Contacts 1a-1b of the switch are opened simultaneously to prevent the relays associated with the remaining circuit groups from being energized unless their associated switches are closed. The relays of the selected circuit groups are energized when cam 58A9(C13) closes its contacts at 40 degrees of cam rotation (S 5.5.3.1).

4.3 NO-TWO INTERLOCK CIRCUIT

The no-two interlock circuit detects the selection of more than one control mode or voltage group. If such a selection is made, the no-two interlock circuit initiates an excursion-stop sequence and lights the SEQUENCE FAULT indicator on the MC control panel.

No-two interlock relay 58A14AA10 is energized when power is applied to the Marginal Checking System (S 5.5.1.1, sect. 1). The relay is energized through:

a. Normally closed contacts 3a-3b of manual-mode relay 58A14BB19

b. Normally closed contacts 4a-4b of satellite-mode relay 58A14BB20
c. Normally closed contacts 6a-6b of calculator-mode relay 58A14BB22
d. Normally closed contacts 6a-6b of each of the voltage-select relays 58A14Z13, 58A14Z15, 58-A14Z17, 58A14Z19, and 58A14Z21.

A hold circuit is provided through contacts 1a-1c of the energized no-two interlock relay so that the relay will not be de-energized if a second selection is made while an excursion is applied to the load circuits.

4.3.1 Monitoring Mode Selection

Before the excursion is started, the no-two interlock circuit can detect the selection of more than one mode of control or more than one voltage. The normal energizing circuit for relay 58A14AA10 is through normally closed contacts of the manual- and satellite-mode relays. If the manual mode is selected, the energizing circuit is through now-closed contacts 3a-3c of the manual-mode relay, normally closed contacts 3a-3b of the satellite-mode relay, and normally closed contacts 6a-6b of the calculator-mode relay. If either the satellite or calculator mode is selected while the manual mode is selected, the circuit will be broken and relay 58A14AA10 will drop. A similar analysis shows that only one voltage group can be selected.

4.3.2 No-Two Interlock Action

When more than one voltage group is selected, the circuit for relay 58A14AA10 is broken and the relay drops. The normally closed contacts of this relay perform the following functions:

a. Contacts 3a-3b close to complete the circuit to excursion-stop relay 58A14AA3 (S 5.5.1.1, sect. 3).
b. Contacts 4a-4c open to extinguish the READY lamp on the maintenance console (S 5.5.11.1).
c. Contacts 5a-5b close to light the SEQUENCE FAULT lamp on the maintenance console (S 5.5.11.1).

4.4 VOLTAGE- AND CIRCUIT-SELECTED CIRCUIT

The voltage- and circuit-selected circuit detects the absence of a voltage-group selection. This circuit detects these omissions after an excursion is begun.

4.4.1 Monitoring Voltage Selection

The energizing circuit of voltage- and circuit-selected relay 58A14AA12 is conditioned by contacts of the selected voltage contactor (S 5.5.1.1, sect. 10).

If a voltage has been selected, the relay will be energized when the contacts of cam 58A9(C17) close at 180 degrees of cam rotation. If no voltage is selected, the relay cannot be energized, and an interlock action will take place (4.4.2).

No provision is made in this circuit to detect a multiple voltage-group selection. The selection of more than one voltage group is detected by the no-two interlock circuit.

4.4.2 Interlock Action of Voltage and Circuit Selection Circuit

The interlock action of this circuit results from the fact that no voltage group is selected. If a voltage group is not selected, the voltage-group relays are not energized because the contacts of all voltage-group switches are open (S 5.5.3.2).

If a voltage group is not selected, relay 58A14AA12 will not be energized and an excursion cannot be initiated. Consequently, the EXCURSION ON lamp will not light (S 5.5.11.1, sect. 6).

4.5 EXCURSION START SEQUENCE

An excursion is started in the manual mode by depressing the START EXCURSION pushbutton (S 5.5.1.1, sect. 4). Normally open contacts 1a-1c of the START EXCURSION pushbutton close to complete the energizing circuits to cam-start relays 58A14AA2 and 58A14J5 (fig. 4—11). Both relays are energized through closed contacts of 58A9(C14), contacts 1a-1b of the STOP EXCURSION pushbutton, contacts of cam 58A10(C17), contacts 1a-1c of the START EXCURSION pushbutton, contacts 12-13 of calculator-mode relay 58A14C6, contacts 3a-3c of amplidyne-control-CB relay 58A14AA11, contacts 2a-2c of power-on relay 58A14AA15, and contacts 2a-2c of recycle-interlock relay 58A14AA1 (S 5.5.1.1, sect. 4).

The contacts of relay 58A14J5 energize the clutch of cam 58A9 and cause the cams to rotate to complete the selection of the equipment to be marginally checked (par. 4.2).

In manual-mode operations, cam unit 58A10 is not rotated because excursion magnitude, polarity, and duration are controlled manually.

4.6 EXCURSION CONTROL

In manual mode, the magnitude, polarity, and duration of an excursion are controlled by the operator at the duplex maintenance console. Control is accomplished by varying a potentiometer and observing the voltage variation on a voltmeter.

4.6.1 Reference Input Circuit

The 125V reference voltage is connected to the amplidyne control circuit through the following portions of the reference input circuit: Contacts of the ±125V interlock relay 58A14J1, contacts of the selected safe-limit relays, and the manual-excursion potentiometer (S 5.5.8.1). Refer to paragraph 2.3.5, Section 2, for the process of connecting the reference-voltage power supply output to the reference-input circuit.

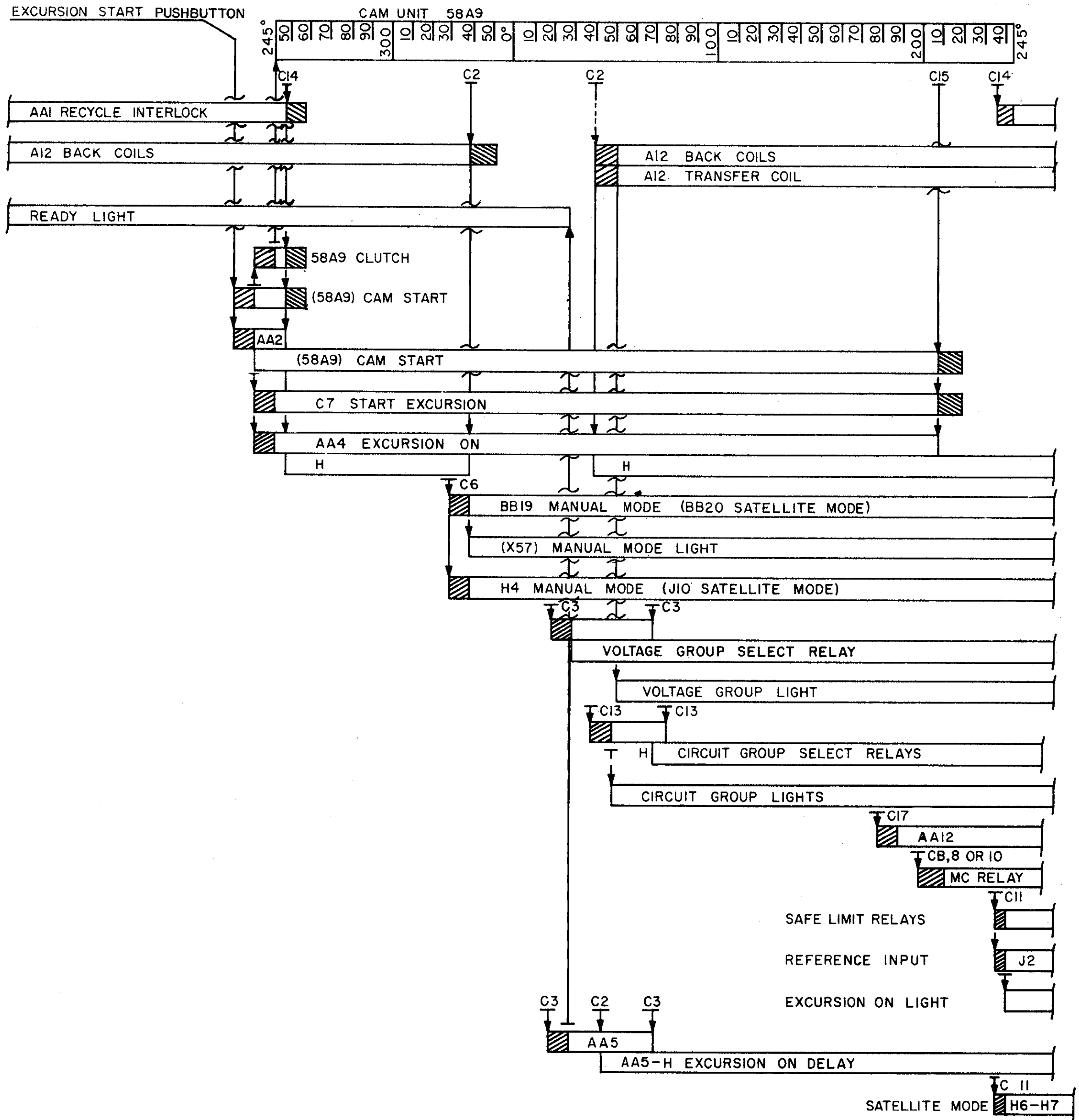


Figure 4–11. Start Excursion Sequence, Manual Mode, Simplified Sequence Chart

4.6.2 Safe-Limit Selection

The safe-limit selection circuit protects the circuits being marginally checked from excessive increases or decreases in voltage. The safe-limit selection is made at the voltage-divider network in the reference-input control circuitry.

Two voltage-divider networks are provided for the manual mode of operation. Each voltage-divider network is connected to the output of a reference-voltage power supply. One network is used with the +125Vdc supply; the other with the —125Vdc supply. The polarity of the safe-limit voltage corresponds to the polarity of the network. The method of selecting a safe limit in manual mode is the same as that in calculator mode. This process is discussed in paragraph 3.4.3, Section 3

4.6.3 Excursion Polarity Control

The excursion voltage either increases or decreases the voltage applied to a circuit during an MC test. The direction of voltage variation depends upon the polarity of the reference-input voltage to the amplidyne.

In manual mode, the polarity of the reference-input voltage is controlled by the direction of rotation of the

excursion-potentiometer control. A clockwise rotation of the control causes the excursion to increase in the positive direction; a counterclockwise rotation causes an increase in the negative direction.

4.6.4 Excursion Magnitude Control

In manual mode, the magnitude of the excursion is controlled by manual operation of the potentiometer mounted on the MC control panel. Three complete revolutions of the potentiometer control move the adjustable contactor from one extreme of the potentiometer to the other. The voltages tapped off the voltage-divider network by the safe-limit selections (par. 4.6.2) are connected to opposite ends of the potentiometer (S 5.5.8.1). The center of the potentiometer is connected to ground potential. The movable contact is connected to the manual-mode reference-input line. From the zero-voltage point (the midpoint of the divider) the potentiometer control knob can be moved in either direction to control the magnitude of the excursion voltage. The direction of movement determines the polarity of the excursion voltage (par. 4.6.3); the amount of movement determines the magnitude of the excursion voltage. Since only the safe-limit voltage is applied to the potentiometer, the excursion voltage can never exceed the safe-limit voltage.

A voltmeter installed in the MC-control panel is connected to the amplidyne output. The amount of excursion voltage applied to the circuits is registered on this meter.

4.6.5 Applying The Excursion

The voltage contactors and the MC relays perform the same functions in both manual and calculator mode of control (par. 3.5.6).

4.6.6 Excursion Duration Control

In the manual mode, the duration of the excursion is controlled by the potentiometer at the MC control panel of the duplex maintenance console. An excursion will remain on the selected circuits until the excursion voltage is returned to zero by operating the potentiometer control. The amount of excursion is determined by observing the EXCURSION VOLTMETER mounted above the potentiometer control.

4.7 CHANGE EXCURSION SEQUENCE

In manual mode, the excursion voltage is varied by changing the setting of the excursion-control potentiometer. The magnitude of the excursion voltage is determined by the distance the movable contact is moved from the center or zero-voltage position. The duration of the excursion voltage is determined by the length of time the setting of the potentiometer remains constant. Therefore, a change-excursion sequence in manual mode consists of changing the setting of the potentiometer on the maintenance console.

4.8 STOP EXCURSION SEQUENCE

The stop-excursion sequence is initiated by energizing stop-excursion relay 58A14AA3 (S 5.5.1.1, sect. 3). This relay is energized in all modes of control during the stop-excursion sequence. Relay 58A14AA3 is energized in manual mode by depressing the STOP EXCURSION pushbutton. The relay is energized through contacts 1a-1c of the pushbutton and contacts 4a-4c of relay 58A14AA1. When relay 58A14AA3 is energized, cam unit 58A9, the safe-limit relays, the MC relays, the mode relays, the voltage contactors, and the voltage-group relays are deselected. These deselection processes are identical in both the manual and the calculator mode (par. 3.7.3 through 3.7.3.8).

CHAPTER 4

SUMMARY OF DIFFERENCES BETWEEN DUPLEX AND SIMPLEX MC SYSTEMS

4.1 INTRODUCTION

This chapter summarizes the differences between the duplex and the simplex MC systems. In general, the differences between the two systems occur in the physical location of certain components and, thus, in the component nomenclature. Additional components in the simplex MC system are necessary to allow the control line switching required for the calculator mode of operation.

4.2 DIFFERENCES IN RELAY LOCATION

Certain functions common to the duplex and simplex MC systems are performed or controlled by relays located differently within the corresponding units. These relays are listed in table 4–3 according to the function of the component.

4.3 MC FUNCTIONS UNIQUE TO THE SIMPLEX MC SYSTEM

Certain components in the simplex MC system perform functions which have no counterpart in the duplex MC system. Most of these unique functions are associated with the switching process which allows the simplex MC system to be calculator-controlled by the standby computer (table 4–3).

4.3.1 Calculator Control-Line Switching

The MC-control lines to the simplex MC system must be switched when the computer status is switched. The switching process connects the control lines from the standby computer to the calculator-controlled relays of the simplex MC system. These calculator-controlled relays are controlled by contacts of the corresponding relay in the duplex MC system (S 5.5.4.1). Each relay representing a bit position of the MC word in the Central Computer has two possible pick circuits. One circuit is conditioned by the relay contacts of the corresponding bit position in the computer A test register; the other circuit is conditioned by the relay contacts of the corresponding bit position in computer B. The selection of the proper pick circuit is performed by the contacts of standby relays. These standby relays are energized when the associated computer is in the standby status (S 5.4.10.2). With this arrangement, a particular calculator-controlled relay in simplex marginal checking is energized by power from the standby computer if the corresponding calculator-controlled relay in the standby computer is conditioned by a 1 in that bit position of the MC control word.

4.3.2 Interlock Circuits

Certain power-interlock circuits are contained in MC unit 58. Corresponding interlock circuits are found in the duplex equipment in areas remote from the MC control circuits. The power-interlock circuits are contained in MC unit 58 so that one set can be used for the power from both the C and D power systems. These interlock circuits are shown on S 5.4.10.2.

4.4 MC FUNCTIONS UNIQUE TO DUPLEX MC SYSTEM

Certain operations in the duplex MC system have no application in the simplex MC system. These functions and the associated relays are listed in table 4–3 and are explained briefly below.

4.4.1 MC Equipment Group Selection

The calculator-controlled relays which control the MC equipment group selection (RS-R3) in the calculator mode are not applicable to the simplex MC system. There is no MC group division of the simplex equipment, and, therefore, it is not necessary to provide for MC group selection. The MC group selection pushbuttons at the MC control panel are not included in the simplex MC system.

4.4.2 Safe-Limit Values

Certain safe-limit voltage values are not applicable to the circuits in the simplex equipment. Therefore, the +50-, —50-, and —75-volt safe-limit relays are not used in the simplex MC systems.

TABLE 4—3. DUPLEX AND SIMPLEX NOMENCLATURE DIFFERENCES

DUPLEX SYSTEM RELAY	FUNCTION	SIMPLEX SYSTEM RELAY
Y20, Y21, Y23	Mode relays	BB19, BB20, BB22, H6, H7
AA13–AA17	Voltage-group relays	Z13–Z22
DD1–DD23, Z20–Z24	Circuit-group relays	X1–X24, Y20–Y24
AA19–AA24	Calculator-controlled relays (R4–R9)	Z1–Z6
Z1–Z6	Calculator-controlled relays (R10–R15)	Z6–Z12
CC7	Duration stop	AA13
CC8	Amplidyne off	AA14
DD24	Test (duplex) or power on	AA15
	Restart buffers	AA18, AA19
	Excursion-duration buffers	AA20, AA21
	+72-volt Sensitrol relay	D12
	Excursion off	H10, 58B6H3
	Excursion on	58B6G3
	Computer standby relays	58B2G2, -G3, H2, -H3, -J2, -J3, -K2, K3; 58B6J2, -J3, -K2, -K3
BB19–BB22	Calculator-controlled relays (RS–R3)	
CC1–CC6	Simplex relays	
CC9–CC24	MC group relays	
G6–G9, H5–H10	Satellite isolation relays	
63A12F	Amplidyne fail contactor	
K2, K7, K8	+50, —50, —75-volt safe limits	

Note: Prefix all duplex system relays with 63A14 unless full nomenclature is expressed. Prefix all simplex system relays with 58A14 unless full nomenclature is expressed.

PART 5
MAGNETIC TAPE POWER SUPPLY MARGINAL CHECKING

5.1 GENERAL

The magnetic tape power supply (unit 18) contains facilities which allow any of the output voltages of this unit to be varied a maximum of approximately 30 volts. Although this circuit is not part of the Marginal Checking System, its function is essentially the same.

A relay matrix inserts a variable MC voltage in series with any one of the five normal d-c voltages required by the tape units. The variable voltage is varied until a failure occurs or until the maximum MC voltage is reached. A zero-sense circuit insures that the variable voltage is 0 ± 0.5V at the time that the output is switched between voltage lines.

5.2 CIRCUIT OPERATION

Figure 5—1 is a simplified schematic of the variable-voltage source (5.3.3.11, sheet 7). Regulated 208Vac is applied across motor-driven autotransformer 18F(T1) and input transformer 18F(T2). The a-c voltage is rectified by a bridge rectifier, filtered by an inductance-capacitance L-type filter, and applied across rheostat

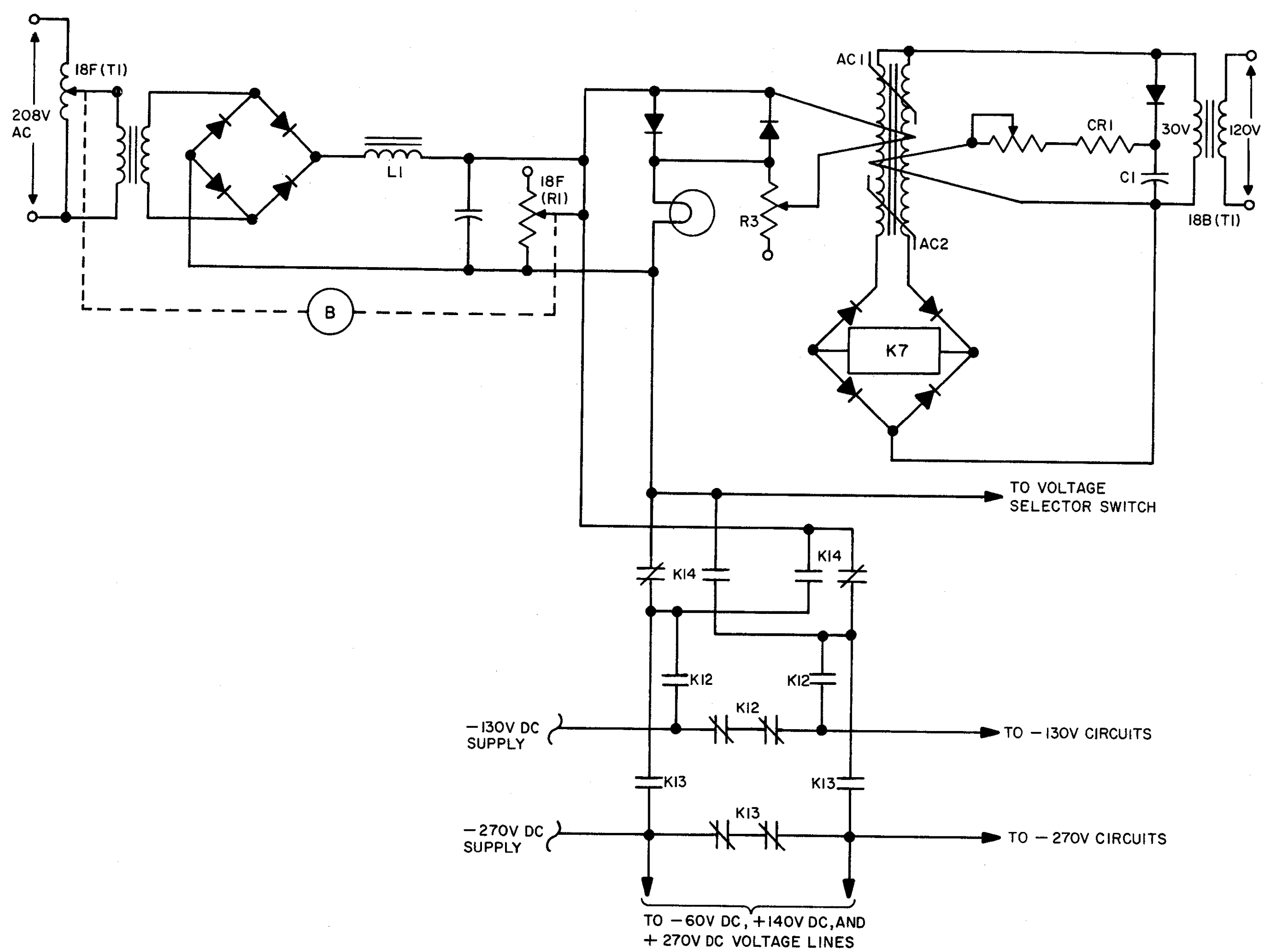


Figure 5—1. Variable D-C Power Supply for Magnetic Tape Marginal Checking, Simplified Schematic

18F(R1). The filtered d-c voltage developed across the rheostat is the d-c output of the supply.

5.2.1 Zero-Sense Circuit

The zero-sense circuit (5.3.3.11, sheet 8) prevents the output voltage of the MC power supply from being switched between d-c voltage lines if the MC power supply output is greater than 0 ± 0.5V (par. 5.2.3). The magnetic amplifier 18B(AM) and the associated bridge rectifier are balanced so that relay 18B(K7) is energized when the voltage across 18F(R1) exceeds 0 ± 0.5V. Bias is applied to the AC2 section of the magnetic amplifier (fig. 5—1) by the secondary of transformer 18B(T1) through rectifier 18B(CR1), and capacitor 18B(C1). When no input is applied to the AC1 section the impedance of the windings is high, and the amount of current flowing through the bridge rectifier is insufficient to energize relay 18B(K7).

When the voltage across 18F(R1) exceeds ±0.5V, sufficient current flows in the AC1 section to reduce the impedance of the windings. As the impedance decreases, sufficient current flows through the bridge rectifier to energize relay 18B(K7). When relay 18B(K7) is energized, contacts 7-8 (5.3.3.11, sheet 9) open to disable the ACTIVATE switch and prevent the initiation of an excursion.

5.2.2 Excursion Polarity

The polarity of the excursion is determined by the condition of relay 18B(K14). When this relay is de-energized, its contacts a-h and d-e are closed (5.3.3.11, sheet 8). These closed points connect the voltage across 18F(R1) in series with the d-c voltage line so that the voltage across 18F(R1) adds to the voltage of the d-c supply. When the POLARITY REVERSE switch (5.3.3.11, sheet 9) is closed, —48V dc is applied through normally closed contacts 17-18 of relay 18B(K1) to the coils of relay 18B(K8) and 18B(K14). When relay 18B(K14) is energized, contacts a-h and d-e open and contacts a-b and e-f close. The configuration of the contacts now connects the voltage across 18F(R1) and the d-c voltage line in series so that the voltage across 18F(R1) opposes the voltage of the d-c supply.

5.2.3 Line Selection

Assume that the LINE SELECTION switch (shown as CIRCUIT SELECTION switch on 5.3.3.11, sheet 9) is operated to select the —130Vdc power supply. A simplified schematic of the selection circuit is shown in figure 5—2. For clarity, only the relays associated with the —270Vdc supply and the selected —130Vdc supply are shown. The tape drive units are receiving —130Vdc and —270Vdc through normally closed contacts of relays K12 and K13, respectively (fig. 5—1).

When the ACTIVATE pushbutton is depressed, power is applied through normally closed contacts of relay K7, and contacts of the ACTIVATE and LINE SELECTOR switches to the coils of relays K5 and K12. Relay K12 is associated with the —130Vdc circuit; K5 establishes a hold circuit for K12 when the ACTIVATE

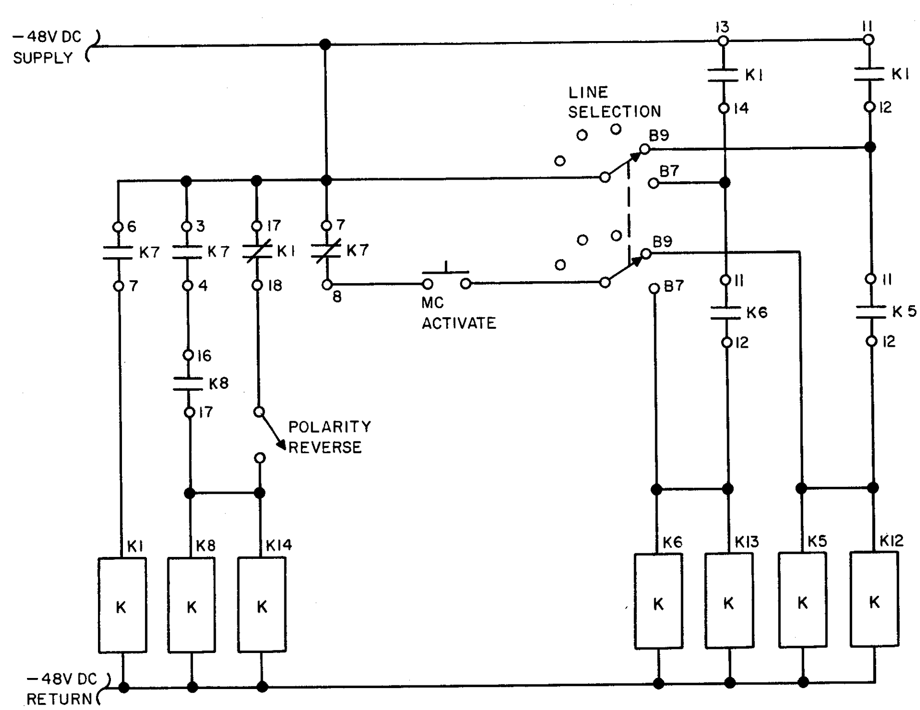


Figure 5—2. Typical Circuit Selection Circuit, Simplified Schematic

pushbutton is released. The normally open contacts of K12 close and the normally closed contacts open (figs. 5–1 and 5–2). The transfer of these contacts places potentiometer 18F(R1) in series with the —130Vdc power supply. An excursion is applied to the —130Vdc circuit by varying the voltage across potentiometer 18F(R1). The excursion is controlled by depressing the EXCURSION INCREASE pushbutton and observing the voltage on the voltmeter.

Note

The voltmeter RANGE SELECTOR switch may be placed in the —130 position to read the total voltage on the —130Vdc circuit, or in the 0–30 position to read the output of the MC-voltage supply.

As the voltage across 18F(R1) increases from 0 to ±0.5V relay K7 opens and its normally closed contacts open. Simultaneously, relay K1 is energized by one set of normally open contacts of relay K7. The normally closed contacts of K1 open to de-activate the POLARITY REVERSE pushbutton during the excursion.

Normally open points of relay K1 close in each of the circuit-selection hold circuits to prevent the circuit selection relays from dropping if the LINE SELECTOR switch is operated while an excursion is on.

When the excursion voltage is returned to 0 ± 0.5V, relays K7 and K1 are de-energized and the circuit is prepared for another line selection.

If the POLARITY REVERSE pushbutton is depressed prior to the excursion, relay K8 is energized and a hold circuit for relays K1 and K7 is established by contacts of relay K8. Simultaneously, POLARITY REVERSE relay K14 is energized. Contacts of relay K14 (5.3.3.11, sheet 8) transfer to connect the variable supply into the selected d-c circuit so that the excursion direction is reversed.

Relays K6 and K13 correspond to relays K5 and K12, but are associated with the —270Vdc power supply.

PART 6

DIFFERENCES BETWEEN DC AND CC MARGINAL CHECKING

6.1 INTRODUCTION

There is no basic difference between the Marginal Checking System for AN/FSQ-7 and that for AN/FSQ-8. The theory of operation and the method of making MC tests is the same for both equipments.

In AN/FSQ-7 equipment, units 7, 8, and 9 are replaced by units 65, 66, and 67 (256^2 memory and associated units). In AN/FSQ-8 equipment, units 34, 41 and 93 are not installed. Consequently, certain MC selections are not applicable to AN/FSQ-8 equipment. These nonapplicable selections are listed in table 6–1.

Note

Since units 7, 8, and 9 (Memory I) are identical to units 10, 11, and 12 (Memory II), the MC selections applicable to Memory I are applicable to Memory II.

6.2 AN/FSQ-7 MC SELECTIONS NOT APPLICABLE TO AN/FSQ-8 EQUIPMENT

Table 6–1 is a listing of the AN/FSQ-7 selections that are not used for testing AN/FSQ-8 equipment. The entries of the following listing, if deleted from the complete listing of MC selections found in Part 5, *Logic Index, AN/FSQ-7 and AN/FSQ-8* will result in a list of selections applicable only to AN/FSQ-8 equipment. The column heads are explained as follows:

V = Marginal checking voltage
MC = Marginal checking equipment group
C/L = Circuit and line (circuit for simplex equipment)
Unit = Unit number
Type = Circuit type
Description = Circuit function
Logic = Number of logic block schematic drawing

TABLE 6–1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
250	1	A1	67	SWD	YU Selection	0–2.1.5
250	1	A2	67	SWD	YV Selection	0–2.1.5
250	1	A3	65	SWD	XU Selection	0–2.1.5
250	1	A4	65	SWD	XV Selection	0–2.1.5
250	1	A5	65	CR	XU Selection	0–2.1.5
250	1	A6	65	CR	XV Selection	0–2.1.5
250	1	B5	67	CR	YU Selection	0–2.1.5
250	1	B6	67	CR	YV Selection	0–2.1.5
250	1	C2	65	PCA	MAR R15	0–2.1.5
250	1	C2	65	PCA	MAR R14	0–2.1.5
250	1	C2	65	PCA	MAR R13	0–2.1.5
250	1	C2	65	PCA	MAR R12	0–2.1.5
250	1	C2	65	PCA	MAR R11	0–2.1.5

TABLE 6—1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT (cont'd)

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
250	1	C2	65	PCA	MAR R10	0—2.1.5
250	1	C2	65	PCA	MAR R9	0—2.1.5
250	1	C2	65	PCA	MAR R8	0—2.1.5
250	1	C2	67	PCA	MAR R7	0—2.1.5
250	1	C2	67	PCA	MAR R6	0—2.1.5
250	1	C2	67	PCA	MAR R5	0—2.1.5
250	1	C2	67	PCA	MAR R4	0—2.1.5
250	1	C2	67	PCA	MAR R3	0—2.1.5
250	1	C2	67	PCA	MAR R2	0—2.1.5
250	1	C2	67	PCA	MAR R1	0—2.1.5
250	1	C2	67	PCA	MAR RS	0—2.1.5
250	1	C3	65	BFN	TAPE CORE BIAS	0—2.1.5
250	1	C5	67	PCF	INH GG	0—2.1.4
150	1	A2	67	CF	Y RGG	0—2.1.4
150	1	A2	65	CF	X RGG	0—2.1.4
150	1	A2	65	CF	SAMPLE GG	0—2.1.4
150	1	A3	67	CF	INH GG	0—2.1.4
150	1	B1	65	PCF	IA DSL	0—2.1.5
150	1	C1	65	BFN	TAPE CORE BIAS	0—2.1.5
90	1	B1	65	DD	MPD 1	0—2.1.4
90	1	B1	65	DD	MPD 2	0—2.1.4
90	1	B1	65	PA	MPD 3	0—2.1.4
90	1	B1	67	PA	MPD 4	0—2.1.4
90	1	B1	67	GT	CL SAMPLE GG AND MPD 4	0—2.1.4
90	1	B1	65	PA	CL MEM CONTROLS	0—2.1.4
90	1	B1	65	GT	DPD SEL GATES LW	0—2.1.4
90	1	B1	65	GT	DPD SELECT GATES RW	0—2.1.4
90	1	B2	65	GT	SAMPLE GG	0—2.1.4
90	1	B2	67	SA	SENSE AMP RIGHT HALF WORD	0—2.1.6
90	1	B2	65	SA	SENSE AMP LEFT HALF WORD	0—2.1.6
90	1	B3	67	SA	SENSE AMP RIGHT HALF WORD	0—2.1.6
90	1	B3	65	SA	SENSE AMP LEFT HAI F WORD	0—2.1.6

TABLE 6—1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT (cont'd)

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
—150	1	A1	65	AFF	MAR R15	0—2.1.5
—150	1	A1	65	AFF	MAR R14	0—2.1.5
—150	1	A1	65	AFF	MAR R13	0—2.1.5
—150	1	A1	65	AFF	MAR R12	0—2.1.5
—150	1	A1	65	AFF	MAR R11	0—2.1.5
—150	1	A1	65	AFF	MAR R10	0—2.1.5
—150	1	A1	65	AFF	MAR R9	0—2.1.5
—150	1	A1	65	AFF	MAR R8	0—2.1.5
—150	1	A1	67	AFF	MAR R7	0—2.1.5
—150	1	A1	67	AFF	MAR R6	0—2.1.5
—150	1	A1	67	AFF	MAR R5	0—2.1.5
—150	1	A1	67	AFF	MAR R4	0—2.1.5
—150	1	A1	67	AFF	MAR R3	0—2.1.5
—150	1	A1	67	AFF	MAR R2	0—2.1.5
—150	1	A1	67	AFF	MAR R1	0—2.1.5
—150	1	A1	67	AFF	MAR RS	0—2.1.5
—150	1	A2	67	AFF	Y RGG	0—2.1.4
—150	1	A2	65	AFF	X RGG	0—2.1.4
—150	1	A3	65	AFF	SAMPLE GG	0—2.1.4
—150	1	A3	67	AFF	INH GG	0—2.1.4
—150	1	A5	65	BFN	TAPE CORE BIAS	0—2.1.5
—150	1	B1	65	AFF	IA DSL	0—2.1.5
—150	1	C1	65	CR	XV Selection	0—2.1.5
—150	1	C2	65	CR	XU Selection	0—2.1.5
—150	1	C3	67	CR	YV Selection	0—2.1.5
—150	1	C4	67	CR	YU Selection	0—2.1.5
—300	1	A1	67	DPD	RIGHT HALF WORD	0—2.1.6
—300	1	A1	67	DPD	DIGIT PLANE DRIVER RIGHT HALF WORD	0—2.1.6
—300	1	C1	65	IA	XV Selection	0—2.1.5
—300	1	C2	65	IA	XU Selection	0—2.1.5
—300	1	C3	67	IA	YU Selection	0—2.1.5
—300	1	C4	67	IA	YV Selection	0—2.1.5
250	7	B1	41	PCF	LRI PULSE DISTRIB	B—2.4.6

TABLE 6—1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT (cont'd)

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
250	7	B2	41	LA	LRI READ OUT CONTROL	B—2.4.6
250	7	B2	41	LA	LRI READ OUT CONTROL	B—2.4.6
250	7	B2	41	LA	LRI READ OUT CONTROL	B—2.4.6
250	7	B2	41	LA	LRI READ OUT CONTROL	B—2.4.6
250	7	B2	41	LA	LRI LONG WORD	B—2.4.6
250	7	B2	41	I	LRI SITE PARITY	A—2.4.6
250	7	B2	41	LAI	LRI WORD 1 PARITY	B—2.4.6
250	7	C1	93	I	SITE DISPLAY SELECTOR	2.5.2
250	7	C1	93	I	MULT MESSAGE LABEL DISPLAY SEL	2.5.2
250	7	C1	93	I	SINGLE MESSAGE LABEL DISPLAY SEL	2.5.2
150	7	B1	34	CF	MAP CNTR SITE IDENT	A—2.14
150	7	B2	41	CF	LRI LONG WORD	B—2.4.6
150	7	B2	41	CF	LRI WORD LEVEL	B—2.4.6
150	7	B2	41	CF	LRI SITE PARITY	A—2.4.6
150	7	B2	41	CF	LRI WORD 1 PARITY	B—2.4.6
150	7	B3	41	CF	LRI PULSE DISTRIB	A—2.4.6
150	7	B3	41	CF	LRI CLOCK	A—2.4.6
150	7	B4	41	CF	LRI DISPLAY TIME COUNTER	S—2.4.5
150	7	B4	41	CF	LRI READ OUT CONTROL	A—2.4.6
150	7	B4	41	CF	LRI SITE IDENTITY	B—2.4.6
150	7	C1	93	CF	REGISTER CORRECTOR	2.5.1
150	7	C1	93	CF	SITE AND MESSAGE LABEL STORAGE REG	2.5.1
150	7	C2	93	CF	DISPLAY TIMING	2.5.2
150	7	C2	93	CF	SITE DISPLAY SELECTOR	2.5.2
150	7	C2	93	CF	MULT MESSAGE LABEL DISPLAY SEL	2.5.2
150	7	C2	93	CF	SINGLE MESSAGE LABEL DISPLAY SEL	2.5.2
90	7	B1	34	BPA	MAP CNTR COM EQ OD 2	A—2.1.3
90	7	B1	34	BPA	MAP CNTR DATE AVAILABLE	A—2.1.4
90	7	B2	34	GT	MAP CNTR OD-2 CNTR	A—2.1.3
90	7	B2	34	GT	MAP CNTR GATED DRUM DEMAND	A—2.1.3

TABLE 6—1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT (cont'd)

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
90	7	B2	34	GT	MAP CNTR COM EQ OUTPUTS	A—2.1.4
90	7	C1	41	GT	LRI DRUM DEMAND	S—2.4.5
90	7	C1	41	GT	LRI READ OUT CONTROL	B—2.4.6
90	7	C1	41	GT	LRI WORD 1 AND 2 READ OUT	A—2.4.6
90	7	C2	41	GT	LRI DISPLAY TIME COUNTER	S—2.4.5
90	7	C2	41	GT	LRI CLOCK CONTROL	A—2.4.6
90	7	C2	41	GT	LRI CLOCK PARITY	A—2.4.6
90	7	C2	41	GT	LRI SITE PARITY	A—2.4.6
90	7	C3	41	GT	LRI PULSE DISTRIB	A—2.4.6
90	7	C4	93	GT	WORD DISCRIMINATOR	2.5.1
90	7	C4	93	GT	DISPLAY TIMING	2.5.2
90	7	C5	93	GT	DISPLAY TRIGGER GENERATOR	2.5.2
90	7	C6	93	GT	DISPLAY TIMING	2.5.2
90	7	D1	41	PA	LRI DRUM DEMAND	S—2.4.5
90	7	D2	41	PA	LRI PULSE DISTRIB	A—2.4.6
90	7	D2	41	PA	LRI CLOCK CONTROL	A—2.4.6
90	7	D3	93	PA	SINE STORAGE REG	2.5.1
90	7	D3	93	PA	COSINE STORAGE REG	2.5.1
90	7	D3	93	PA	DATA AVAILABILITY UNIT	2.5.1
90	7	D3	93	PA	REGISTER RESET UNIT	2.5.1
90	7	D3	93	PA	DISPLAY TIMING	2.5.2
90	7	E3	41	BPA	LRI READ OUT CONTROL	B—2.4.6
90	7	E3	41	BPA	LRI PULSE DISTRIB	A—2.4.6
—150	7	A2	41	AFF	LRI DRUM DEMAND	S—2.4.5
—150	7	A2	41	AFF	LRI PULSE DISTRIB	B—2.4.6
—150	7	A3	93	AFF	WORD DISCRIMINATOR	2.5.1
—150	7	A3	93	AFF	MESSAGE LABEL STORAGE REG	2.5.1
—150	7	A3	93	AFF	SITE STORAGE REG	2.5.2
—150	7	B3	41	CF&	LRI SITE PARITY	A—2.4.6
—150	7	B5	93	CF&	REGISTER CORRECTOR	2.5.1
—150	7	B6	93	CF&	DISPLAY TIMING	2.5.2
—150	7	B6	93	CF&	SITE DISPLAY SELECTOR	2.5.2
—150	7	B6	93	CF&	DISPLAY TRIGGER GENERATOR	2.5.2
—150	7	B6	93	CF&	MULT MESSAGE LABEL DISPLAY SEL	2.5.2

TABLE 6—1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT (cont'd)

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
—150	7	B6	93	CF&	SINGLE MESSAGE LABEL DISPLAY SEL	2.5.2
—150	7	C3	93	BFF	DISPLAY TIMING	2.5.2
—150	7	D2	41	APG	LRI RESET PARITY ERROR AND ALARM	A—2.4.6
—300	7	B1	34	CFF	MAP CNTR DRUM DEMAND	A—2.1.3
—300	7	B1	34	CFF	MAP CNTR OD-2 CNTR	A—2.1.3
—300	7	C1	41	CFF	LRI DRUM DEMAND	S—2.4.5
—300	7	C2	41	CFF	LRI DISPLAY TIME COUNTER	S—2.4.5
—300	7	C2	41	CFF	LRI READ OUT CONTROL	B—2.4.6
—300	7	C3	41	CFF	LRI PULSE DISTRIB	A—2.4.6
—300	7	C3	41	CFF	LRI CLOCK CONTROL	A—2.4.6
—300	7	C4	41	CFF	LRI ALARM	S—2.4.5
—300	7	C4	41	CFF	LRI CLOCK	A—2.4.6
—300	7	C4	41	CFF	LRI ALARM	A—2.4.6
—300	7	D1	93	CFF	SINE STORAGE REG	2.5.1
—300	7	D1	93	CFF	COSINE STORAGE REG	2.5.1
—300	7	D1	93	CFF	RANGE STORAGE REG	2.5.1
—300	7	D1	93	CFF	DATA AVAILABILITY UNIT	2.5.1
—300	7	D1	93	CFF	RANGE STORAGE REG	2.5.1
—300	7	D1	93	CFF	WORD DISCRIMINATOR	2.5.1
—300	7	D1	93	CFF	DISPLAY TIMING	2.5.2
250	9	B	34	DCR	MAP CNTR DDR CONVERTER	S—2.1.2
250	9	B	41	DCR	LRI DATA CONVERTER AND SYNC	S—2.4.2
250	9	C	41	LA	LRI BUSY BIT SHIFT	S—2.4.2
250	9	D	34	FD	MAP CNTR AZ N SIGNAL PROTECT	S—2.1.2
250	9	F	34	PI	MAP CNTR CNTR AND REG SHIFT DRIVE	S—2.1.2
250	9	G	34	CPG	MAP CNTR AZ N SIGNAL PROTECT	S—2.1.2
250	9	H	34	CLA	XTL TIMING AZN PROTECT	S—2.1.2
250	9	J	34	PAD	MAP CNTR AZ N SIGNAL PROTECT	S—2.1.2
250	9	J	34	APAD	MOTOR DRIVE	S—2.1.6—3

TABLE 6–1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT (cont'd)

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
150	9	A	34	CF	MAP CNTR AZ N SIGNAL PROTECT	S–2.1.2
150	9	A	34	CF	MAP CNTR AZ N SIGNAL PROTECT	S–2.1.2
150	9	A	34	CF	MAP CNTR NORTH SYNCHRONIZER	S–2.1.2
150	9	A	34	CF	MAP CNTR DDR CONVERTER	S–2.1.2
150	9	A	34	CF	MAP CNTR INPUT CNTRL	S–2.1.2
150	9	A	34	CF	MAP CNTR DRUM DEMAND	S–2.1.2
150	9	A	34	AC	ANALOGUE COMPUTER	S–2.1.2
150	9	A	41	CF	LRI CL AND LOAD CORE BFR	S–2.4.6
150	9	F	34	PI	MAP CNTR CNTR AND REG SHIFT DRIVE	S–2.1.2
150	9	G	34	AGC	MAP CNTR TRIANGULAR WAVE GEN	S–2.1.2
90	9	A	34	GT	MAP CNTR AZ N SIGNAL PROTECT	S–2.1.2
90	9	A	34	GT	MAP CNTR INPUT CNTRL	S–2.1.2
90	9	A	34	GT	MAP CNTR DDR CONVERTER	S–2.1.2
90	9	A	34	GT	MAP CNTR DATA AVAILABLE	S–2.1.2
90	9	A	41	GT	LRI PARITY COUNT	S–2.4.2
90	9	A	41	GT	LRI FIRST WD PARITY CHECK	S–2.4.2
90	9	A	41	GT	LRI DATA CONVERTER AND SYNC	S–2.4.2
90	9	A	41	GT	LRI DATA CONVERTER AND SYNC	S–2.4.2
90	9	A	41	GT	LRI PARITY COUNT	S–2.4.2
90	9	A	41	GT	LRI FIRST WD PARITY CHECK	S–2.4.2
90	9	A	41	GT	LRI DATA CONVERTER AND SYNC	S–2.4.2
90	9	A	41	GT	LRI DATA CONVERTER AND SYNC	S–2.4.2
90	9	A	41	GT	LRI READOUT AND MISSING SYNC	S–2.4.2
90	9	A	41	GT	LRI SYNC INT PROTECT	S–2.4.2
90	9	A	41	GT	LRI READOUT AND MISSING SYNC	S–2.4.2
90	9	A	41	GT	LRI SYNC INT PROTECT	S–2.4.2
90	9	A	41	GT	LRI FAST SHIFT	S–2.4.2

TABLE 6—1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT (cont'd)

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
90	9	A	41	GT	LRI DR DEMAND AND FAST SHIFT CTL	S—2.4.2
90	9	A	41	GT	LRI FAST SHIFT	S—2.4.2
90	9	A	41	GT	LRI READOUT CTL	S—2.4.2
90	9	A	41	GT	LRI START WD XFER	S—2.4.2
90	9	A	41	GT	LRI READOUT CTL	S—2.4.2
90	9	A	41	GT	LRI START WD XFER	S—2.4.2
90	9	A	41	GT	LRI DR DEMAND AND FAST SHIFT CTL	S—2.4.2
150	9	A	41	CF	LRI FAST SHIFT	S—2.4.2
150	9	A	41	CF	LRI CHANNEL READY	S—2.4.2
150	9	A	41	CF	LRI READOUT CTL	S—2.4.2
150	9	A	41	CF	LRI START WD XFER	S—2.4.2
150	9	A	41	CF	LRI DATA CONVERTER AND SYNC	S—2.4.2
150	9	A	41	CF	LRI FIRST WD PARITY CHECK	S—2.4.2
150	9	A	41	VRD	LRI DRUM DEMAND	S—2.4.2
150	9	A	41	CF	LRI START WD XFER	S—2.4.2
150	9	A	41	CF	LRI CHANNEL READY	S—2.4.2
150	9	A	34	CF	NORTH SYNCHRONIZING	S—2.1.6—3
150	9	A	34	CF	FILTERED TGTS	S—2.1.6
150	9	A	34	BCF	NORTH SYNCHRONIZING	S—2.1.6—5
150	9	A	34	HCF	FILTERED TARGETS	S—2.1.6—5
150	9	B	34	CSD	MAP CNTR INPUT CNTR	S—2.1.2
150	9	B	41	CSD	LRI WD CORE BFR	S—2.4.2
150	9	B	41	CSD	LRI WORD 1 CORE BUFFER	S—2.4.2
150	9	C	41	LA	LRI BUSY BIT SHIFT	S—2.4.2
150	9	D	34	SS	MAP CNTR NORTH SYNCHRONIZER	S—2.1.2
150	9	D	34	SS	MAP CTR NORTH SYNCHRONIZER	S—2.1.2
150	9	D	34	SS	MAP CNTR READ OUT REG DRIVE	S—2.1.2
150	9	D	34	SS	MAP CNTR AZ N SIGNAL PROTECT	S—2.1.2
150	9	D	34	BSS	RADAR NORTH	S—2.1.9—3
150	9	D	34	BSS	STROB	S—2.1.9—3

TABLE 6–1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT (cont'd)

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
150	9	D	34	BSS	SWEEP DRIVE	S–2.1.9–3
150	9	D	34	BSS	AZIMUTH SWEEP DRIVE	S–2.1.6–5
150	9	D	34	BSS	RADAR NORTH	S–2.1.6–5
90	9	B	34	APA	RADAR NORTH	S–2.1.9–3
90	9	B	34	RAW	TGTS	S–2.1.9–3
90	9	B	34	BPA	RAW TARGETS	S–2.1.6–5
90	9	B	34	APA	MOTOR DRIVE	S–2.1.6–5
90	9	C	41	GGCF	LRI CL CORE BFR	S–2.4.2
90	9	C	41	GGCF	LRI WORD 1 CORE BUFFER	S–2.4.2
90	9	D	34	PI	MAP CNTR CNTR AND REG SHIFT DRIVE	S–2.1.2
—150	9	A	34	CF&	MAP CNTR AZ N SIGNAL PROTECT	S–2.1.2
—150	9	A	41	CF&	LRI FAST SHIFT	S–2.4.2
—150	9	A	41	CF&	LRI READOUT CTL	S–2.4.2
—150	9	A	41	CF&	LRI CHANNEL READY	S–2.4.2
—150	9	B	41	DCR	LRI DATA CONVERTER AND SYNC	S–2.4.2
—150	9	B	34	DCR	MAP CNTR DDR CONVERTER	S–2.1.2
—150	9	D	34	SS	MAP CNTR AZ N SIGNAL PROTECT	S–2.1.2
—150	9	D	34	SS	MAP CNTR NORTH SYNCHRONIZER	S–2.1.2
—150	9	D	34	SS	MAP CNTR READ OUT REG DRIVE	S–2.1.2
—150	9	D	34	SS	MAP CNTR DRUM DEMAND	S–2.1.2
—150	9	D	34	BSS	RADAR NORTH	S–2.1.9–3
—150	9	D	34	BSS	STROBE	S–2.1.9–3
—150	9	D	34	BSS	SWEEP DRIVE	S–2.1.9–3
—150	9	D	34	BSS	AZIMUTH SWEEP DRIVE	S–2.1.6–5
—150	9	D	34	BSS	RADAR NORTH	S–2.1.6–5
—300	9	A	34	CFF	MAP CNTR AZ N SIGNAL PROTECT	S–2.1.2
—300	9	A	34	CFF	MAP CNSL SOURCE FOR 34*L CFF	S–2.1.2
—300	9	A	34	CFF	MAP CNTR INPUT DRUM DEMAND CNTRL	S–2.1.2

TABLE 6–1. MC SELECTIONS NOT USED IN AN/FSQ-8 EQUIPMENT (cont'd)

V	MC	C/L	UNIT	TYPE	DESCRIPTION	LOGIC
—300	9	A	34	CFF	MAP CNTR INPUT CNTRL	S—2.1.2
—300	9	A	34	CFF	MAP CNTR DDR CONVERTER	S—2.1.2
—300	9	A	41	CFF	LRI DATA CONVERTER AND SYNC	S—2.4.2
—300	9	A	41	CFF	LRI LOAD DATA AND CL CORE BFR	S—2.4.2
—300	9	A	41	CFF	LRI PARITY AND SYNC INT PROTECT	S—2.4.2
—300	9	A	41	CFF	LRI SYNC INT PROTECT 1	S—2.4.2
—300	9	A	41	CFF	LRI FAST SHIFT	S—2.4.2
—300	9	A	41	CFF	LRI SYNC INT PROTECT 1	S—2.4.2
—300	9	A	41	CFF	LRI FAST SHIFT	S—2.4.2
—300	9	A	41	CFF	LRI CHANNEL READY	S—2.4.2
—300	9	A	41	CFF	LRI START WD XFER	S—2.4.2
—300	9	A	41	CFF	LRI CHANNEL READY	S—2.4.2
—300	9	A	41	CFF	LRI START WD XFER	S—2.4.2
—300	9	A	41	CFF	LRI READOUT CTL	S—2.4.2
—300	9	A	41	CFF	LRI FIRST WD PARITY CHECK	S—2.4.2
—300	9	A	34	CFF	MAP CNTR SHIFT DRIVE CNTRL	2—2.1.2

APPENDIX A
REFERENCE VOLTAGE POWER SUPPLY

A.1 INTRODUCTION

The reference voltage power supplies provide a well-regulated 125Vdc to the amplidyne-control chassis. One supply provides a +125Vdc potential, the other provides a —125Vdc potential. The two supplies are identical except for output-voltage potential.

This appendix discusses the theory of operation of the reference voltage power supplies.

A.2 CIRCUIT CHARACTERISTICS

The reference power supplies have the following circuit characteristics:

Input — Regulated 120Vac

Output — 125Vdc, 0-300 ma. Either the positive or negative output terminal may be grounded.

Output Regulation — Constant output ±1 percent for loads from zero to full load.

Output Noise and Ripple — 10mv rms maximum when the output is regulated within ±1 percent.

A.3.1 Circuit Description

Figure A—1 is a simplified schematic of a reference power supply. The regulated 120Vac input is applied to the primary of transformer T1. The center tapped secondary of T1, together with V4 and V5 forms a full-wave rectifier.

The rectifier output is filtered by a pi-type filter consisting of choke L1 and capacitors C3 and C4. The resistor in parallel with the capacitors is a bleeder resistor. The voltage developed across the bleeder resistor

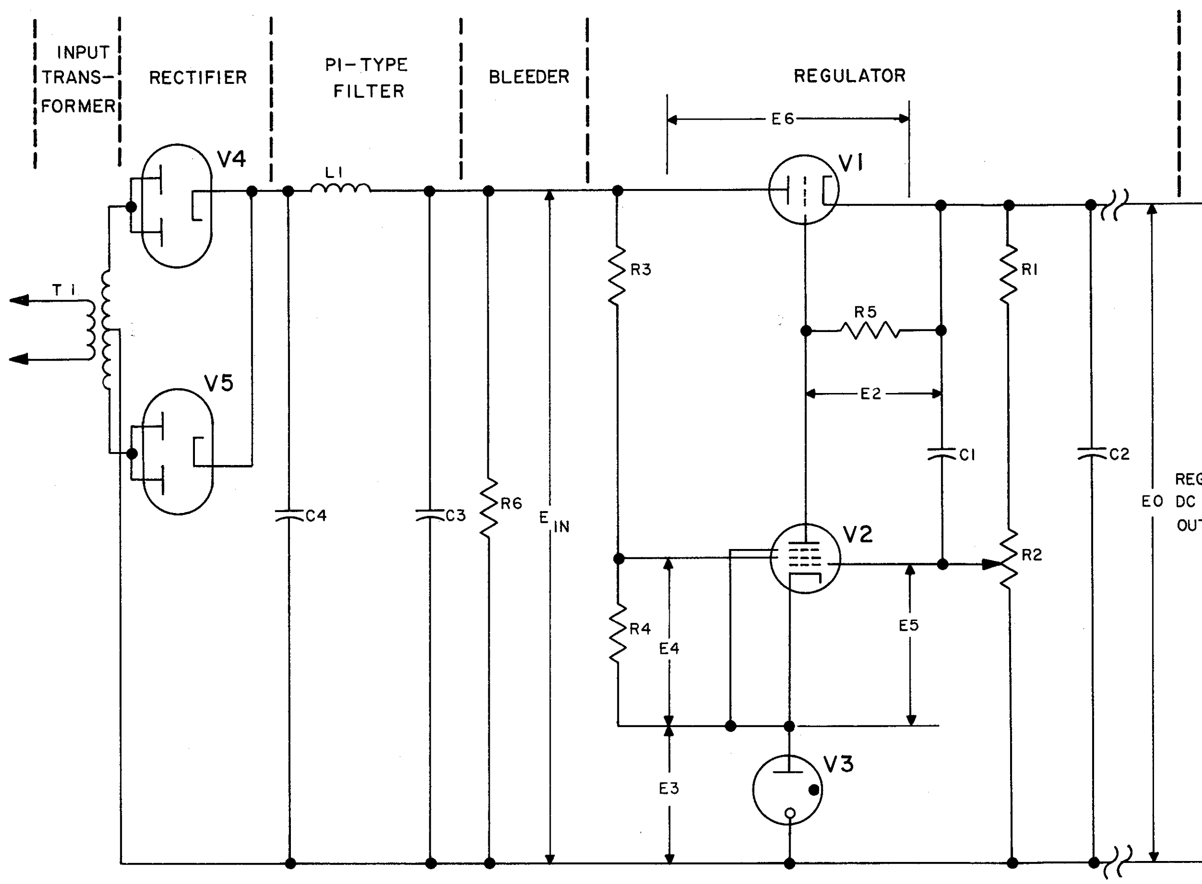


Figure A—1. Reference Voltage Power Supply, Simplified Schematic Diagram

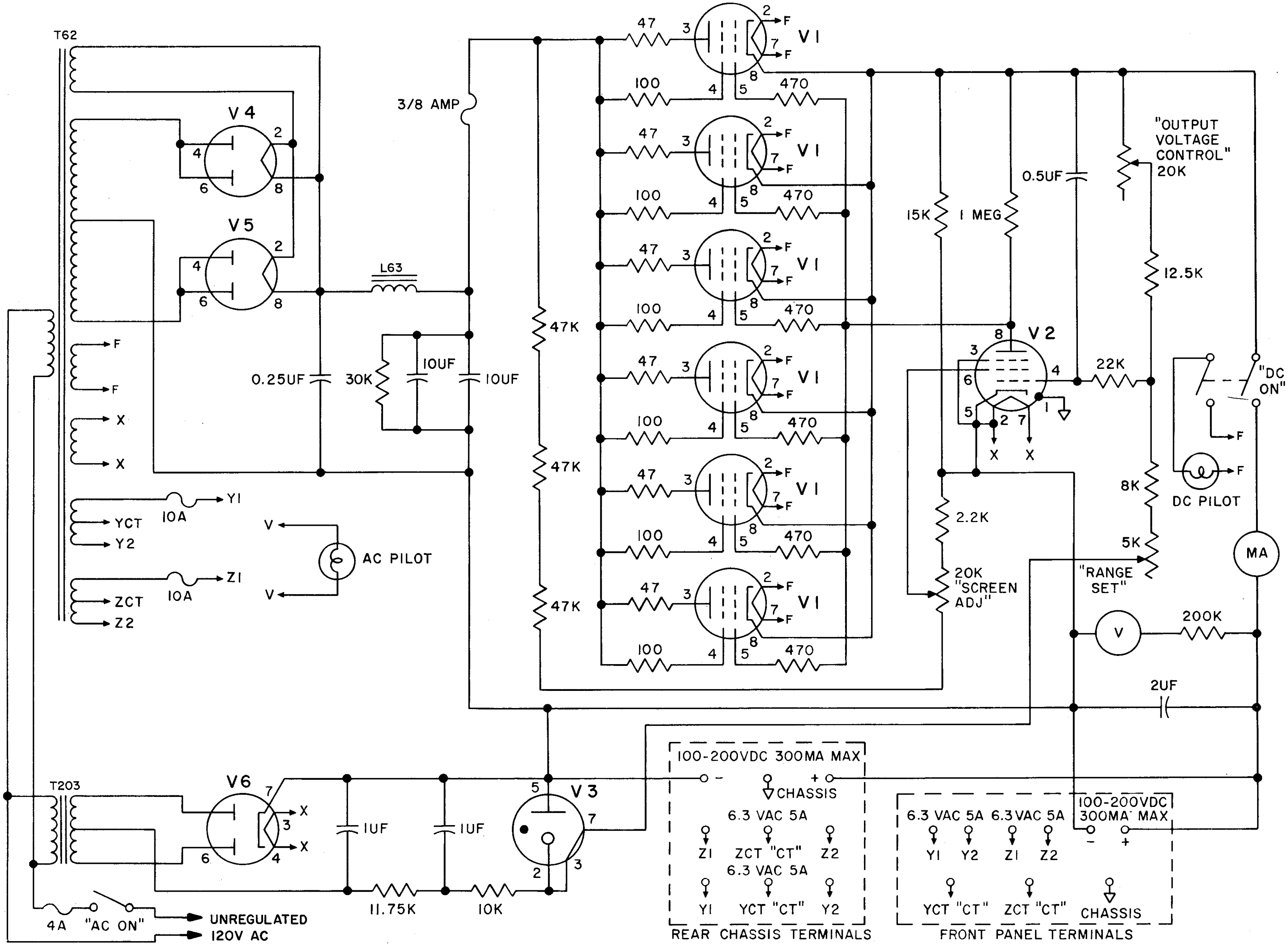


Figure A–2. Reference Voltage Power Supply, Schematic Diagram

is regulated before it is applied to the output terminals of the supply. The method of regulation is discussed below.

A.3.2 Regulation

The reference power supply utilizes two types of regulation. Control grid regulation compensates for voltage variations caused by changes in the load on the supply. Screen grid regulation compensates for variations in input voltage caused by fluctuations in line voltage. In figure A—1, regulation is performed by regulator tube V1, dc-amplifier tube V2, reference voltage tube V3, and the circuit components associated with these tubes.

A.3.2.1 Input Regulation

Assume that the input voltage, E_{in} (fig. A—1) drops because of a fluctuation in line voltage. The cathode voltage (E3) of V2 remains constant because of the constant voltage drop across V3. The screen grid voltage E4 of V3, developed across R4, decreases when E_{in} decreases. Conduction through V2 decreases and the plate voltage of V2 increases. This increase in voltage causes a decrease in the plate voltage of V1 and a corresponding increase in output voltage E_o. Thus the output voltage is increased to compensate for a drop in input voltage.

In a similar manner, an increase in E in causes a decrease in E_o.

A.3.2.2 Output Regulation

Assume that the output voltage E_o decreases because of a change in load. The voltage developed across the output voltage divider R1-R2 decreases. The cathode voltage E3 of V3 remains constant because of the constant voltage drop across V3. The grid-to-cathode voltage E5 of V2 therefore increases; the plate current of V2 decreases; and the plate voltage rises. The rise in the plate voltage of V2 causes a rise in the grid voltage, E2, of V1. When the grid voltage of V1 rises, plate current increases and plate voltage E6 decreases. This decrease in the plate voltage of V1 causes a rise in output voltage which compensates for the original decrease in output voltage.

In a similar manner, if E_o increases V2 plate voltage decreases and V1 plate voltage increases to cause a compensating decrease in E_o.

Capacitor C2 provides further output regulation by filtering out any short transient voltage variations reflected from the load back to the power supply.

A.4 DETAILED CIRCUIT ANALYSIS

Figure A—2 is a schematic diagram of the reference voltage power supply. The tube designations on this drawing correspond to the tube designations on the simplified schematic (fig. A—1).

The 120Vac input is applied to the primary winding of transformer TP62. The center-tapped secondary of the transformer and the two 5R4G4 tubes (V4 and V5) form a full-wave rectifier.

The rectifier output is filtered by two 0.25-µf capacitors choke LF63, and two 10 µf capacitors. The 30K resistor in parallel with the 10 µf capacitors is the bleeder resistor. The d-c output of the rectifiers is applied to the positive output terminal of the six 6LG6 regulator tubes (V1). Six tubes are used in parallel to handle the 300 ma output of the supply. These six tubes, together with the 6SJ7 amplifier tube (V2), and the OA3/VR-75 reference tube (V3) regulate the output of the supply. The center-tap return of transformer TP 63 is connected to the negative output terminal.

Transformer T203, the 6x4 rectifier (V6), and the associated RC filter form a bias power supply. This supply furnishes the voltage for firing V3.

A.5 FUSE PROTECTION

The 4-amp fuse in the primary circuit of the power transformer is mounted on the front panel of the power supply chassis. This fuse protects the power supply from internal overloads or short circuits.

The 3/8-amp fuse in the d-c output circuit is also mounted on the front panel of the power supply chassis. This fuse protects the rectifiers, power transformer and filter choke from overloads and short circuits in the external circuit.

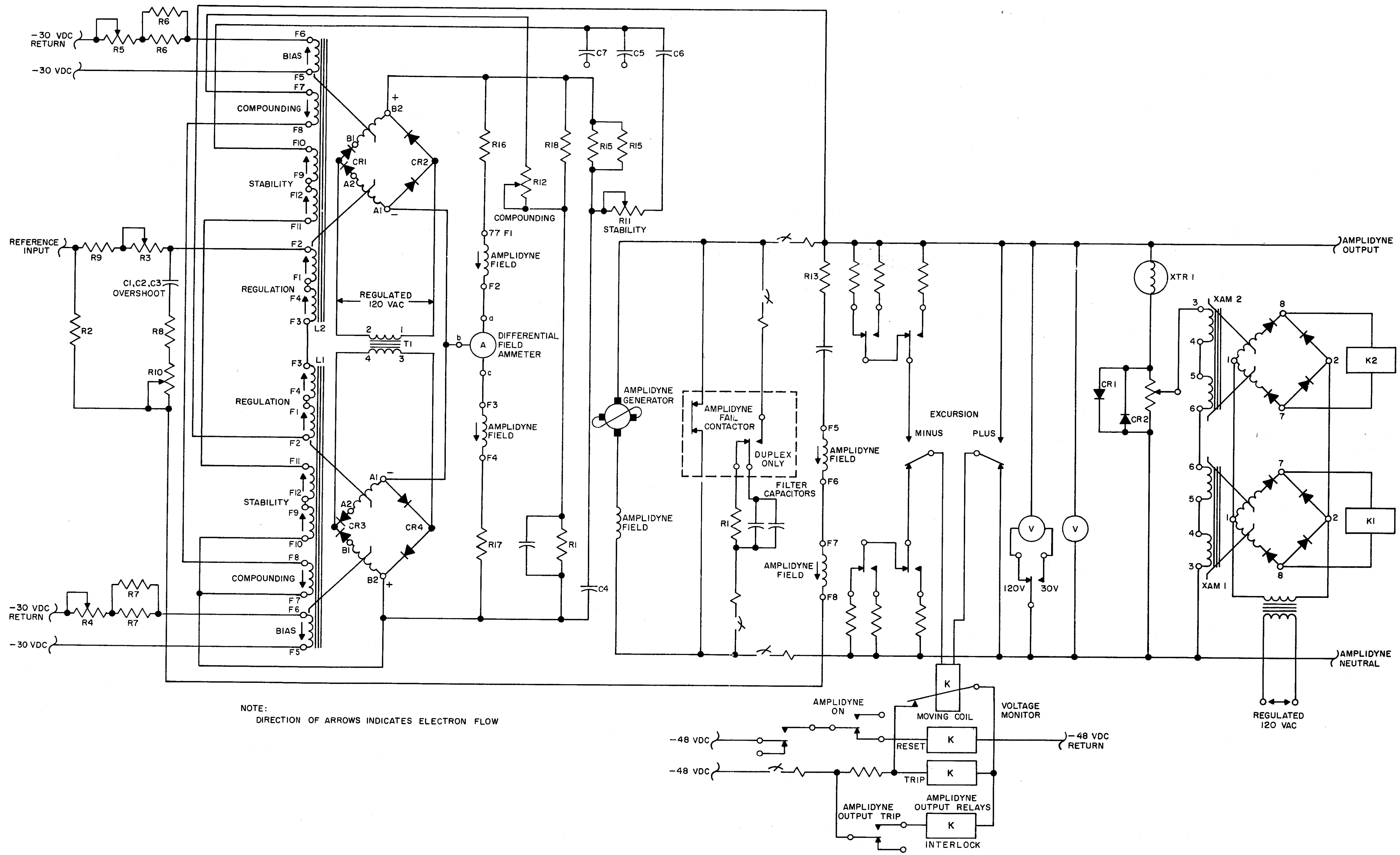


Figure 2–5. Amplidyne and Field Control Chassis, Simplified Schematic Diagram

Figure 3–8. Calculator Mode, Excursion Start, Sequence Chart (Sheet 1 of 3)

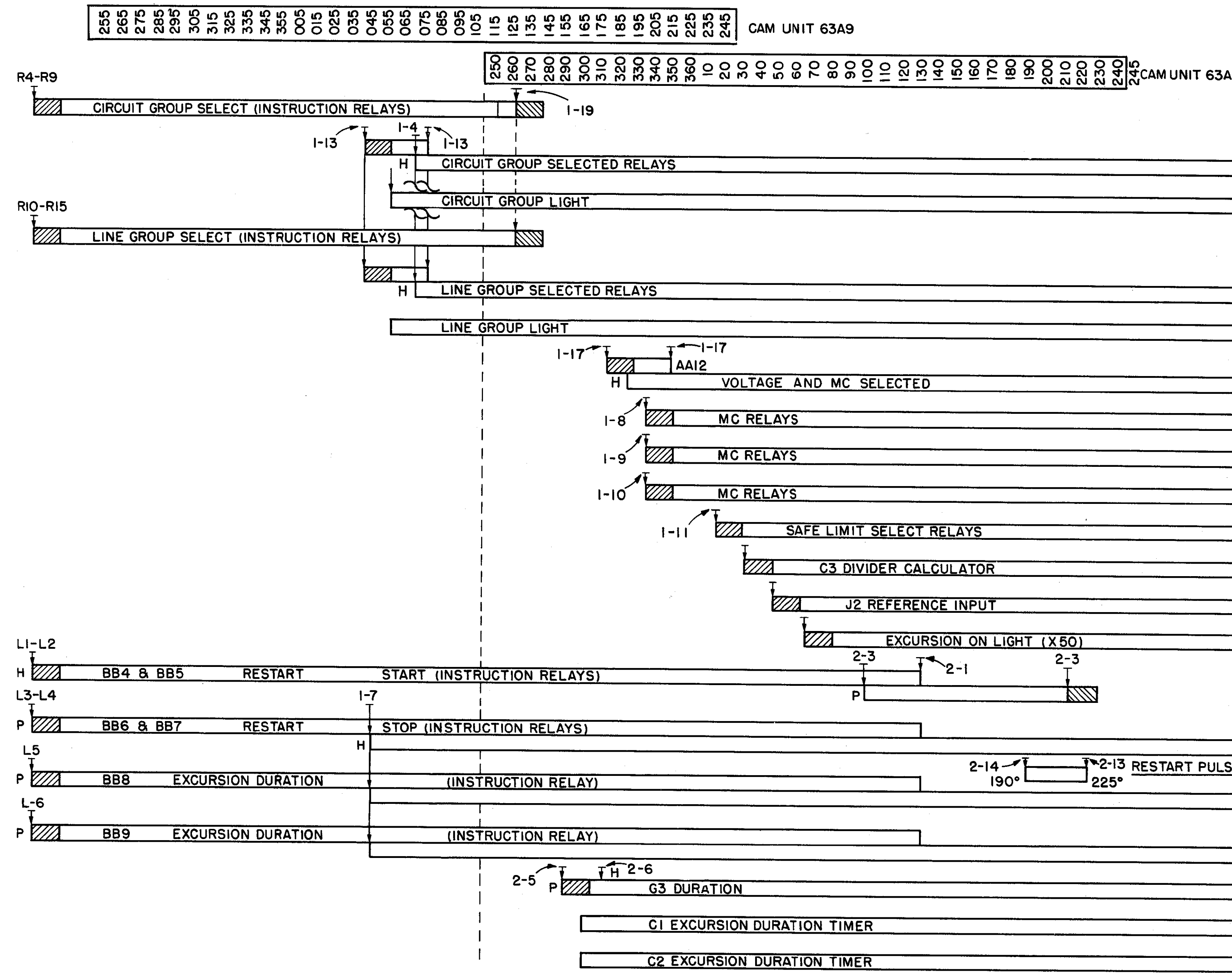


Figure 3-8. Calculator Mode, Excursion Start, Sequence Chart (Sheet 2 of 3)

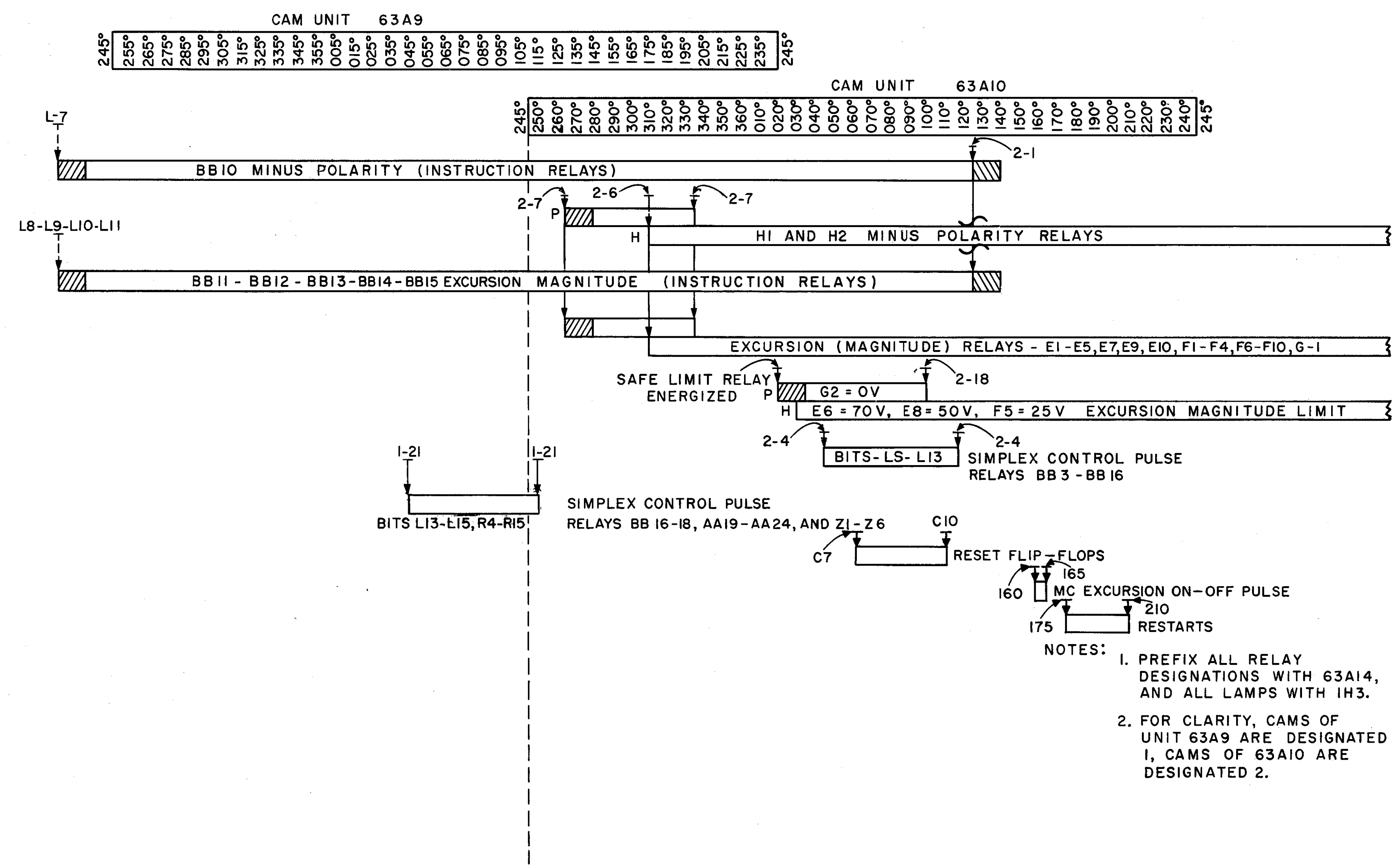
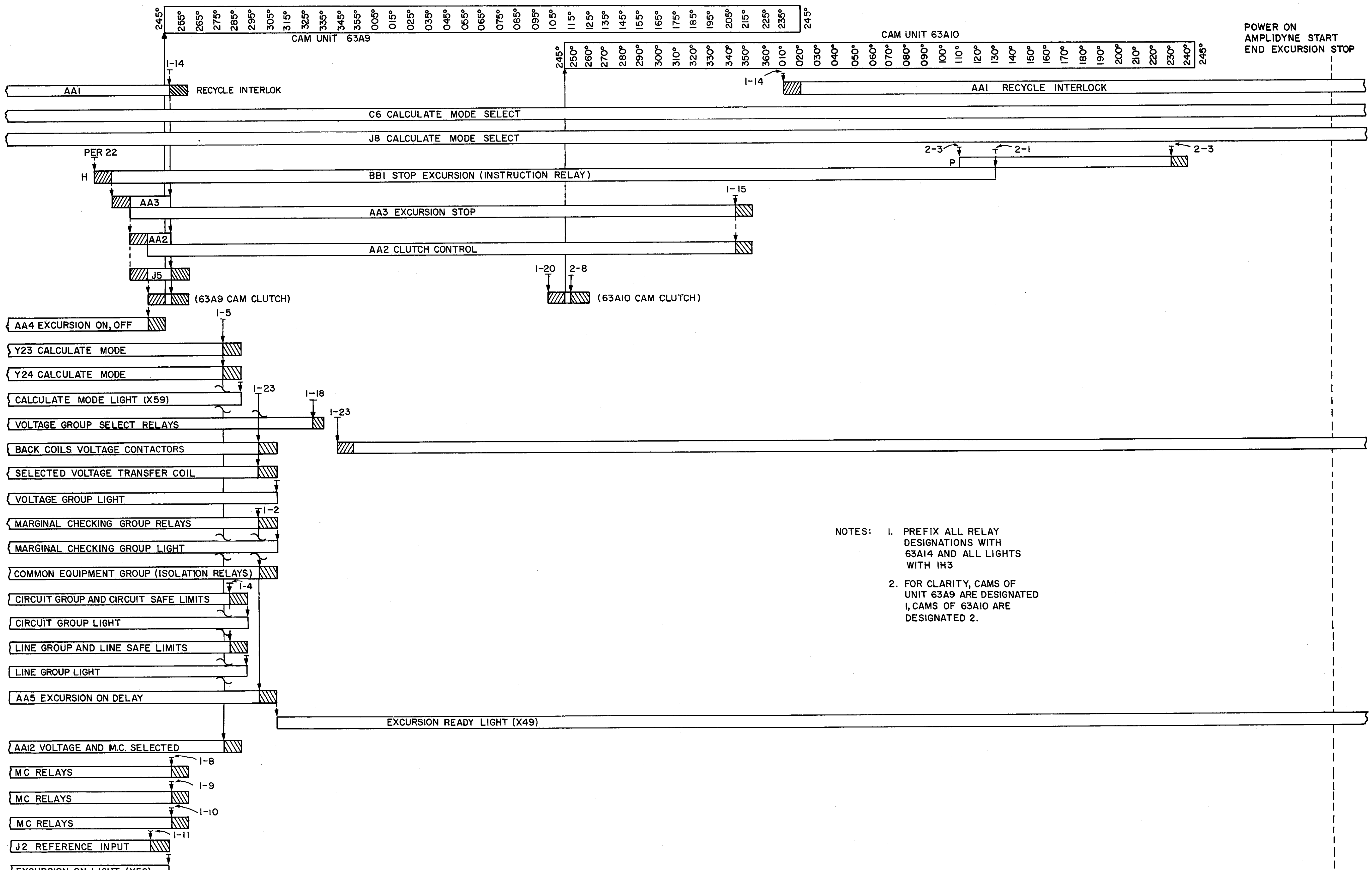
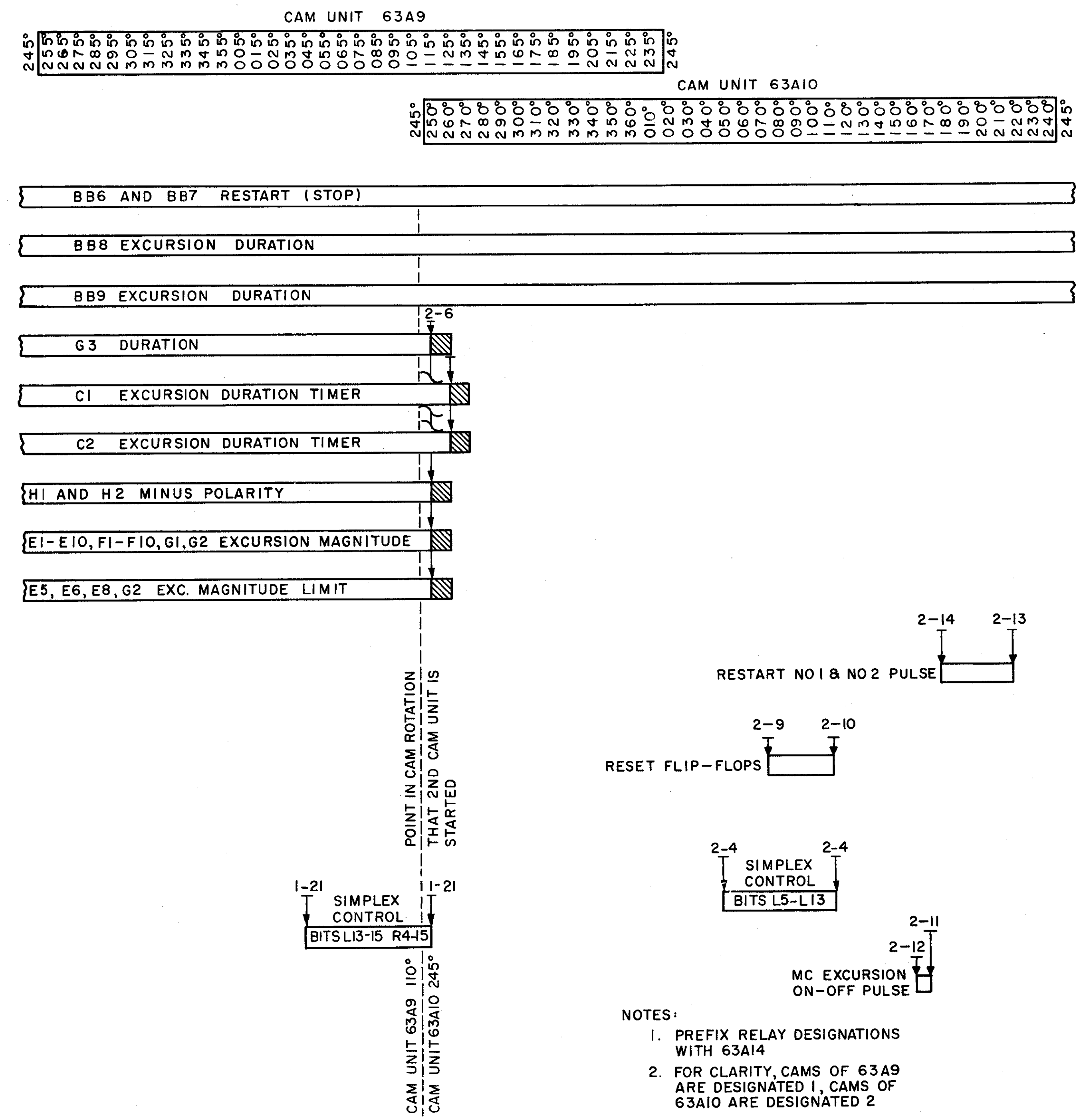


Figure 3–8. Calculator Mode, Excursion Start, Sequence Chart (Sheet 3 of 3)



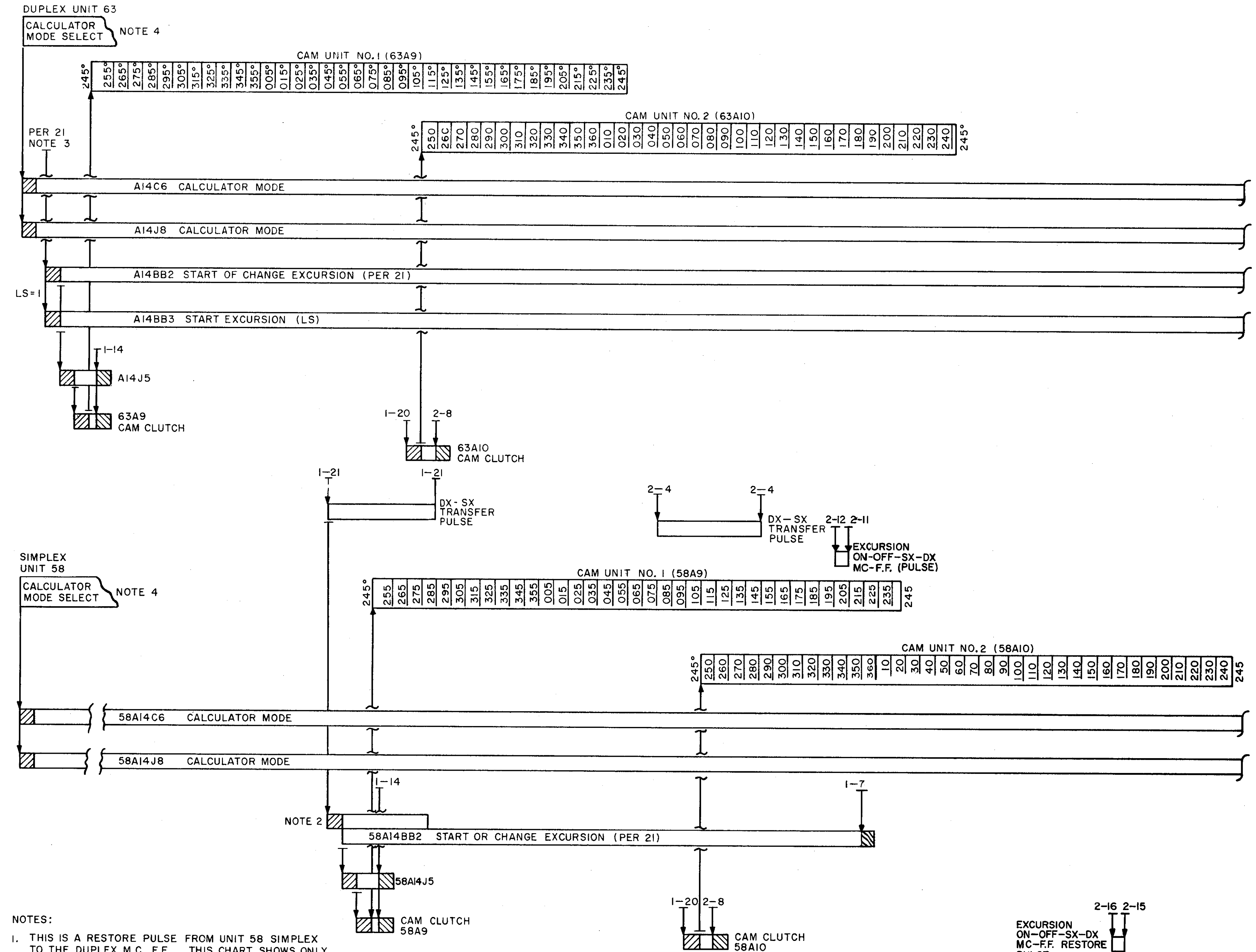
NOTES:
1. PREFIX ALL RELAY DESIGNATIONS WITH 63A14 AND ALL LIGHTS WITH 1H3
2. FOR CLARITY, CAMS OF UNIT 63A9 ARE DESIGNATED 1, CAMS OF 63A10 ARE DESIGNATED 2.

Figure 3–10. Calculator Mode, Excursion Stop, Sequence Chart (Sheet 1 of 2)



NOTES:
1. PREFIX RELAY DESIGNATIONS WITH 63A14
2. FOR CLARITY, CAMS OF 63A9 ARE DESIGNATED 1, CAMS OF 63A10 ARE DESIGNATED 2

Figure 3-10. Calculator Mode, Excursion Stop, Sequence Chart (Sheet 2 of 2)



NOTES:

1. THIS IS A RESTORE PULSE FROM UNIT 58 SIMPLEX TO THE DUPLEX M.C. F.F. THIS CHART SHOWS ONLY THE TIME RELATION BETWEEN 63A9–63A10 AND 58A9–58A10.
2. 58A14BB2 IS TRANSFERRED BY A 63A9 CAM PULSE AT THIS TIME.
3. A SIMPLEX MC WORD SELECTS THE NINTH EQUIPMENT GROUP ON A OPERATE 21 INSTRUCTION. BIT LS=1
4. THE SIMPLEX (UNIT 58) MUST BE IN CALCULATOR MODE. DUPLEX (UNIT 63) MUST BE IN CALCULATOR MODE.

Figure 4–9. Duplex-Simplex Relationship, Excursion-Start Sequence, Calculator Mode

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