Section 6
Power/Vac® Switchgear Equipment

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INTRODUCTION

This section contains information covering typical circuit application packages for Power/Vac® metalclad switchgear equipment.

The first part of this section contains basic equipment description for the protection, instrumentation, and control portions of the equipment. Eleven standard applications are shown, complete with the type of the basic equipment and devices for these commonly used configurations. Charts showing the allowable Power/Vac breaker and auxiliary compartment stacking combinations follow this data. The last part of this section shows a sample lineup developed from the preceding information.

Devices illustrated in Section 6 are assumed to utilize 125V dc control voltage.

To use Section 6, proceed in the following manner:

- Determine the type of each circuit in the one-line diagram (developed in accordance with procedures outlined in Section 2).
- Select from the 11 basic circuit descriptions, the circuits which meet the requirements of the installation.
- Select from the option tables those options desired for the protection, instrumentation, and control portion of each circuit.
- Determine the requirements for auxiliary compartments to house voltage transformers or control power transformers.
- Determine the incoming and outgoing circuit conductor configurations required for each circuit.
- Select the equipment configurations necessary for each circuit and auxiliary compartment from the part of this section covering Breaker and Auxiliary Compartments (pages 6-27 to 6-28).

The basic equipment and options in this section constitute a structured lineup of metalclad equipment. Some lineups, however, may require devices and circuit arrangements other than those included in this section. Contact your GE Sales Representative for additional information.

BASIC EQUIPMENT APPLICATIONS

DEFINITION

A brief definition of each of the 11 basic equipment circuits is given in the following paragraphs.

GENERAL PURPOSE FEEDERS

General purpose feeder (GPF) equipment is a metalclad circuit breaker and compartment controlling and protecting a set of conductors supplying one or more secondary distribution centers, one or more branch-circuit distribution centers, or any combination of these two types of equipment. A general purpose feeder includes circuit overcurrent protection, circuit current indication, and circuit control.

BREAKER BYPASS FEEDERS

Breaker bypass feeder (BBF) is metalclad equipment similar to a general purpose feeder, except two breaker units are connected in parallel to feed a common load. Phase current transformers for both circuit breakers are connected in parallel to a common set of phase relays and instruments. This arrangement is used when a means to remove a feeder circuit breaker for maintenance is desired, yet still maintain service to the connected load. Every breaker bypass vertical section has positions for two circuit breaker removable elements. It is not necessary to include a circuit breaker removable element in each breaker bypass position. One spare circuit breaker removable element per lineup or bus section is usually considered sufficient for each equipment lineup.

TRANSFORMER PRIMARY FEEDERS

Transformer primary feeder (TPF) is similar to a general purpose feeder except, the entire load is one transformer and often includes differential protection for the entire circuit. Liquid filled transformers of a MVA rating to justify differential protection for the circuit are usually equipped with fault-pressure relays for additional internal protection. Both the differential and fault-pressure relays trip a hand reset lockout relay, which trips the primary and secondary transformer circuit breakers.

SINGLE-SOURCE INCOMING LINES

Single source incoming line (SSIL) equipment is metalclad equipment for a circuit to a main power distribution bus from the only source of power supplying the bus. A system with this type of incoming line is called a radial system. A system with two or more incoming lines supplying distribution buses sectionalized by normally open bus-tie circuit breakers requires the same type of protection, instrumentation, and control as single source incoming lines, with the possible exception of the connection of the overcurrent relays.

DUAL SOURCE INCOMING LINES

Dual source incoming line (DSIL) equipment is metalclad equipment for a circuit to a main power distribution bus from one or two sources of power supplying the main bus. The other source of power may be either another incoming line or a local generator. Both sources supply a common distribution bus with or without a normally closed bus-tie circuit breaker.

BUS TIES

Bus-tie (BT) is metalclad equipment connecting two power distribution buses through a tie breaker. Such equipments often are not equipped with overcurrent relays because of the difficulty of obtaining selective system operation with bus-tie overcurrent relays. A bus tie requires two compartments of adjacent sections; see available arrangements later in this section. (Figure 6-15)

BUS ENTRANCES

A bus entrance (BE) is a metalclad vertical section in which one of the compartments contains incoming conductors (cable or bus duct) which are connected directly to the main bus (also referred to as a cable tap). No incoming breaker is used. This arrangement applies to lineups of switchgear, without main circuit breakers, which connect the incoming line directly to the main bus. It also applies to sub feeds, from a lineup of switchgear, without circuit breakers, connecting the outgoing conductors to the main bus.

INDUCTION MOTOR FEEDERS, FULL-VOLTAGE-START

Induction motor feeder (IMF) is similar to a general purpose feeder except it is used for controlling and protecting full-voltage-start motors and is designated as motor “branch circuit” protective equipment. For motors greater than 1500 hp, motor differential protection is typically required.

Reduced-voltage-start applications, utilizing reactors or autotransformers, are available. Contact your GE Sales Representative for additional information.

SYNCHRONOUS MOTOR FEEDERS, FULL-VOLTAGE-START

Synchronous motor feeder (SMF) is similar to an induction motor feeder, except it is used for controlling and protecting full-voltage-start synchronous motors and is designated as motor “branch circuit” protective equipment. For motors greater than 1500 hp, motor differential protection is typically required.

GENERATORS

These metalclad equipments (GEN) connect, control and protect synchronous generators driven by gas turbines or diesel engines.

FUTURE UNIT

These metalclad future unit (FU) compartments are a basic mechanically prepared circuit breaker unit, except the breaker is to be provided at a future date. Provisions are made to receive a breaker of specified rating.
It is recommended to equip these base units with the breaker stationary auxiliary switch and breaker position switch if the active feeders are so equipped, and install current transformers (possibly multiratio). This minimizes field installation, down time and adjustment procedures when the application of this base unit is determined.

The selected relays may be added to the door when the circuit application is determined, or a new door may be purchased with relays and devices completely wired.

GENERAL PURPOSE FEEDERS

DEFINITION

A general purpose feeder equipment (GPF) is a metalclad equipment controlling and protecting a set of conductors supplying one or more branch-circuit distribution centers, one or more branch-circuit distribution centers, or any combination of these centers.

PROTECTIVE SCHEME SELECTION

GPF-1

Use this type of feeder for systems which are impedance or solidly grounded and for which selectivity is not required with down-stream residually connected ground relays.
This type of feeder equipment includes three phase-overcurrent protection (50/51) and one instantaneous overcurrent element (50GS) connected to a ground-sensor CT (GSCT).

GPF-2

Use this type of feeder for systems which are impedance or solidly grounded and for which selectivity is required with down-stream residually connected ground relays. This type of feeder equipment includes three phase-overcurrent protection (50/51) and residually connected time-overcurrent ground element (51N).

GPF-3

Use this type of feeder for ungrounded or solidly grounded systems for which no ground relays are desired. This type of feeder equipment includes three phase-overcurrent protection (50/51) and no ground fault element.

OPTIONAL EQUIPMENT SELECTION

Protection

AUTOMATIC RECLOSING— For open-wire overhead distribution circuits on which this feature is desired, use the GE MIF II, F650 or SR760 relay which includes automatic-reclosing (79) and cut-off switch (79CO) functionality.

Current Transformers for Differential Circuits

For a feeder included in a bus-differential-protected zone, add a separate set of three current transformers located on the outgoing side of the feeder. For a transformer-differential-protected zone, add a separate set of three current transformers located so that the feeder circuit breaker is included in the zone.

Indication

INSTRUMENTATION AND METERING—— Most solid-state protective relays today offer basic load current indication (such as GE's SR735/737& MIF II). Some relays include extensive metering functions such as Amps, Volts, Watts, Vars, PF and demand functions (such as GE's SR750/760, F650, F35 &, F60)

TEST BLOCKS— On circuits that require the provisions for insertion of portable recording meters or other similar devices, add current and voltage test blocks. The basic current test block is wired to maintain the circuit when the test plug is removed.

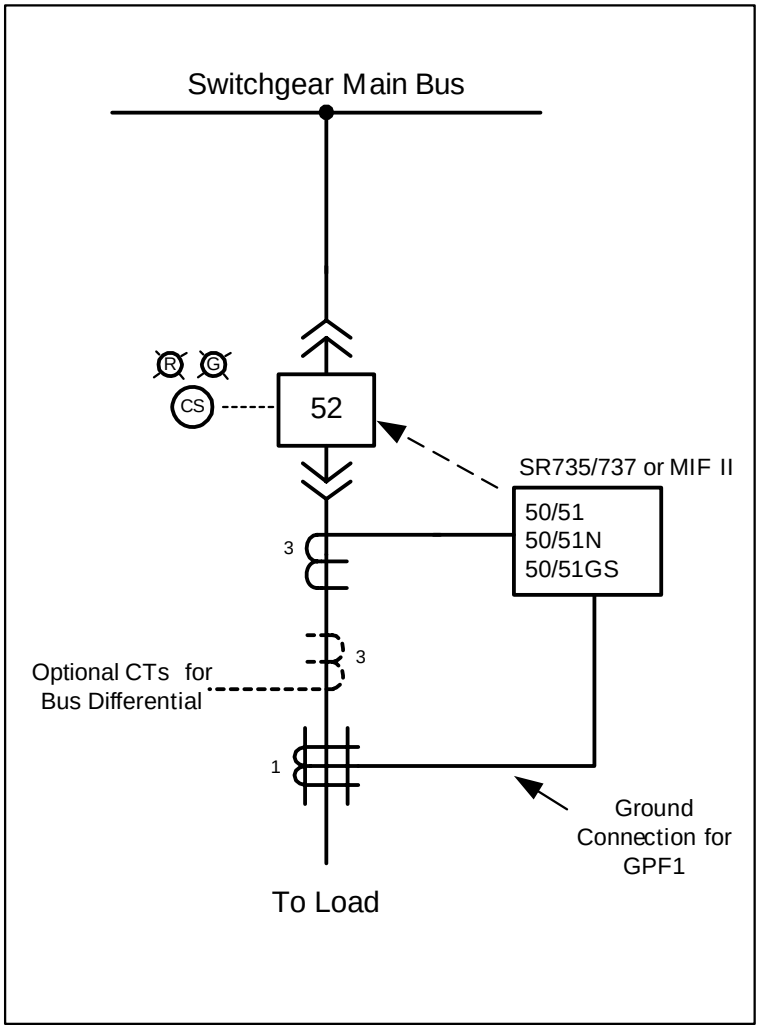
INDICATING LAMP— Additional indicating lamps can be provided, such as for circuits requiring a circuit breaker disagreement or spring-charged indication function.

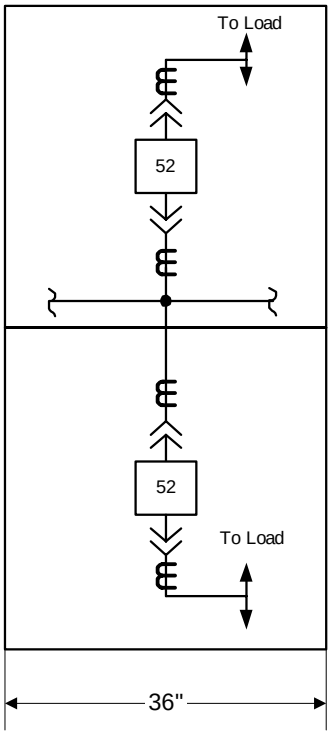
Control

CONTROL VOLTAGE— Available control voltages are 48VDC, 125VDC, 250VDC, 120VAC and 240VAC. For AC control, if a reliable 120/240VAC source is not available at the site, then include a control power transformer connected to each incoming line in each lineup, plus an auto-charged, capacitor-trip device for each circuit breaker in the lineup.

REMOTE CONTROL— For circuit breakers controlled from a remote location, choose the remote control scheme from those listed in Table 5-1 (page 5-7 of this guide). From this table, Scheme C is recommended, since it provides maximum operating flexibility. It requires the use of a breaker position switch in conjunction with the breaker control switch to provide the permissive function. With Scheme C, remote close and trip is possible only with the breaker in the "test" position; and local trip with the breaker in the "connected" or "test" position.

Figure 6-1 General Purpose Feeder





BREAKER BYPASS FEEDERS

DEFINITION

A breaker bypass feeder (BBF) is metalclad equipment similar to a general purpose feeder, except two breaker units are connected in parallel to feed a common load. A complete vertical section (Unit A and Unit B) is required for each breaker bypass feeder circuit. The purpose of this arrangement is to allow removal of the normal service breaker for maintenance without interrupting service on the feeder. Previously, this type of service required either a main and transfer bus arrangement or feeder tie switches.

A lineup utilizing this arrangement of feeders is often specified with only one bypass position breaker element for the lineup, since typically only one feeder circuit breaker is bypassed at a time.

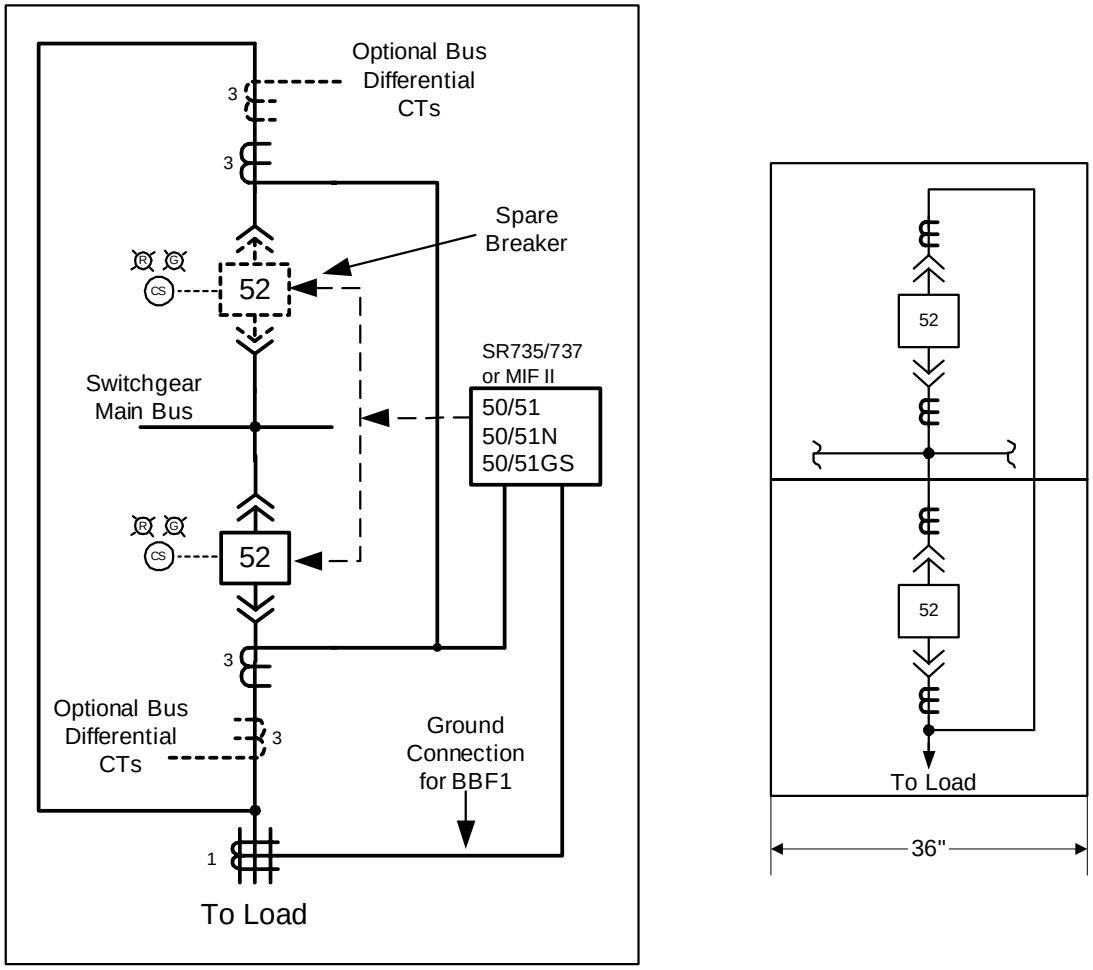
PROTECTIVE SCHEME SELECTION

Basic devices included in a breaker bypass feeder are the same as those included in a general purpose feeder. Select BBF-1, BBF-2, or BBF-3 on the same basis as GPF-1, GPF-2, or GPF-3.

OPTIONAL EQUIPMENT SELECTION

Options for a breaker bypass feeder are the same as for a general purpose feeder. Select options for BBF-1, BBF-2, or BBF-3 on the same basis as for GPF-1, GPF-2, and GPF-3.

Figure 6-2 Breaker Bypass Feeder



TRANSFORMER PRIMARY FEEDERS

DEFINITIONS

A transformer primary feeder (TPF) equipment, is similar to a general purpose feeder except the entire load is one transformer, and the circuit is typically protected with transformer differential relays. If transformer differential protection is not required, use a General Purpose Feeder.

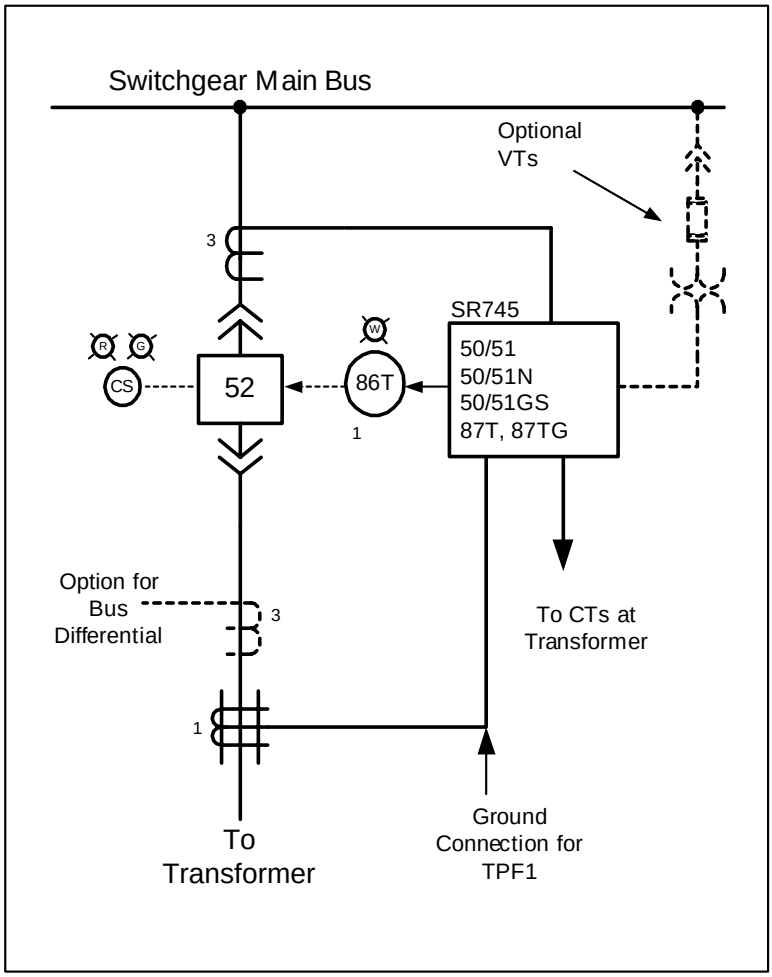
PROTECTIVE SCHEME SELECTION

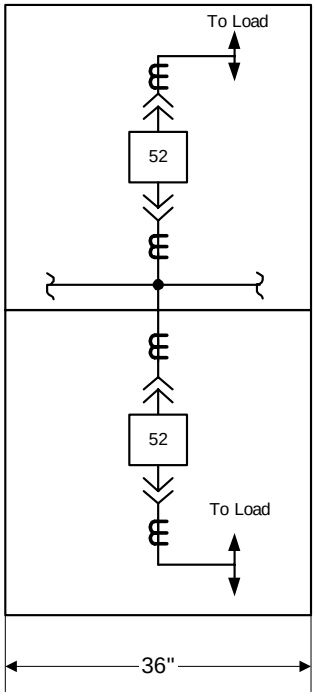
Basic devices included in a transformer primary feeder are the same as those included in a general purpose feeder plus three additional current transformers for the differential protection, a transformer fault-pressure auxiliary relay (63PX) and a HEA lockout relay (86T). Differential protection can be in the form of separate relays, such as GE Type STD single-phase transformer differential relays (87T), or as part of a complete multifunction transformer protection package, like GE's SR745, T35 or T60 relays.

OPTIONAL EQUIPMENT SELECTION

Options for a transformer primary feeder are the same as for a general purpose feeder except that automatic reclosing is not used. Select options for TPF-1, TPF-2, or TPF-3 on the same basis as for GPF-1, GPF-2, or GPF-3.

Figure 6-3 Transformer Primary Feeder





SINGLE SOURCE INCOMING LINES (or dual source with normally open tie breakers)

DEFINITION

A single source incoming line (SSIL) is a metalclad section containing a power circuit breaker, acting as is the main disconnect between a main power distribution bus and the only source of power supplying the bus.

A system with two or more incoming lines, which supply distribution buses sectionalized by normally open bus-tie breakers, requires essentially the same type of protection, instrumentation, and control for each incoming line as a single source incoming line.

PROTECTIVE SCHEME SELECTION

SSIL-1 Use this type of incoming line for an impedance or solidly grounded system fed from a local wye-connected transformer with a current transformer in the transformer neutral connection. This type of incoming line would include three-phase time-overcurrent protection (51), and a ground-over-current element (51G) to be connected to the neutral current transformer of a local power transformer feeding the incoming line.

SSIL-2 Use this type of incoming line for and impedance or solidly grounded system fed from a remote wye-connected transformer, or a local wye-connected transformer with no current transformer in the transformer neutral connection.
This type of incoming line would include three-phase time-overcurrent protection (51), and residually connected ground-overcurrent relay (51N).

SSIL-3 Use this type of incoming line for ungrounded or solidly grounded systems for which no ground relays are desired.
This type of incoming line would include three-phase time-overcurrent protection (51), and no ground relays.

OPTIONAL EQUIPMENT SELECTION

Protection

OVERCURRENT RELAY CHARACTERISTICS — Time current characteristics for overcurrent relays are determined by system studies. After the time current characteristic has been established, make sure the relays selected offer the required time current characteristics that satisfy the application.

CURRENT SUMMATION CONNECTION — For line-ups containing bus-tie breakers, specify the incoming line overcurrent relays to be wired for current summation (also known as partial differential). Add a lockout relay (86) and a set of three CT's mounted on the tie breaker, for each set of relays to be wired this way.

OPEN-PHASE PROTECTION — For incoming lines fed from transformers with fused primaries or sources subject to single-phase operation, add negative-sequence voltage protection (60/47) and time delay (62). The function is available in multi-function relay protection packages, such as GE Type SR750/760 and F650, or as a single function relay Type NBV or MIV II.

TRANSFORMER DIFFERENTIAL PROTECTION — Add differential protection for incoming lines fed from transformers with a means to trip a primary breaker. Differential protection can be in the form of separate relays, such as GE Type STD single-phase transformer differential relays (87T), or as part of a complete multi-function transformer protection package, like GE's SR745, T35 or T60 relays. In addition, add one Type HEA lockout relay (86T), one Type HAA fault pressure auxiliary target relay (63FPX), and a set of three current transformers. For impedance grounded systems with larger transformers and for which three-phase transformer differential relaying is not sensitive enough to detect secondary ground faults, include ground differential relay protection (87TG) with a single function relay GE Type IFD, or as part of a complete multi-function transformer protection package.

BUS DIFFERENTIAL PROTECTION — For systems requiring bus differential protection, add a GE Type MIB three-phase solid state differential protection relay (87B) and one Type HEA hand reset lockout relay (86B). Bus differential requires a dedicated set of three CTs on the incoming line.

CURRENT TRANSFORMERS FOR REMOTELY LOCATED DIFFERENTIAL RELAYS — For incoming lines included in bus or transformer differential zones for which relays are not mounted on the incoming line equipment, add a separate set of three current transformers for each differential function.

DIRECTIONAL POWER, UNDERFREQUENCY, AND UNDERVOLTAGE PROTECTION — To detect utility tie circuit fault conditions prior to automatic reclosing and to initiate programmed load shedding, add, either singly or in combination, a power directional relay (32), underfrequency relay (81), undervoltge relay (27) and timer (62). This applies for systems with local generation or large motors. These features are included in the GE Type SR750 and F650 relays.
A study of each system is required to assure proper selection and circuit location of these relays.

AUTOMATIC THROWOVER — For lineups with a normally open tie breaker or a normally open alternate incoming line breaker, add automatic primary throwover equipment if desired. This consists of two undervoltage relays (27), two multicontact auxiliary relays (27X), two timers (2 and 62), two auxiliary relays (2X and 62X), and one manual-automatic selector switch (43). Automatic throwover equipment requires an empty auxiliary compartment for mounting, custom designed for each application. If using GE Type SR750 multifunction relays on the incoming line and tie breakers, only two timers (2 and 62), two auxiliary relays (2X and 62X), and one manual-automatic switch (43) are required.

Indication

INSTRUMENTATION AND METERING — For incoming lines for which voltage indication and a relay voltage source are not required, omit the voltmeter, voltmeter switch, and two voltage transformers. For circuits requiring the indication or metering of additional electrical quantities, add indicating analog meters as appropriate, or a multifunction meter such as GE Type PQM II. Some relays include extensive metering functions such as Amps, Volts, Watts, Vars, PF and demand functions (such as GE's SR750/760 &, F650).

TEST BLOCKS — For circuits that require the provisions for insertion of portable recording meters or other similar devices, add current and voltage test block. Basic test block is wired to maintain the circuit when the test plug is removed.

INDICATING LAMP —Additional indicating lamps can be provided, such as for circuits requiring a circuit breaker disagreement or spring-charged indication function.

Control

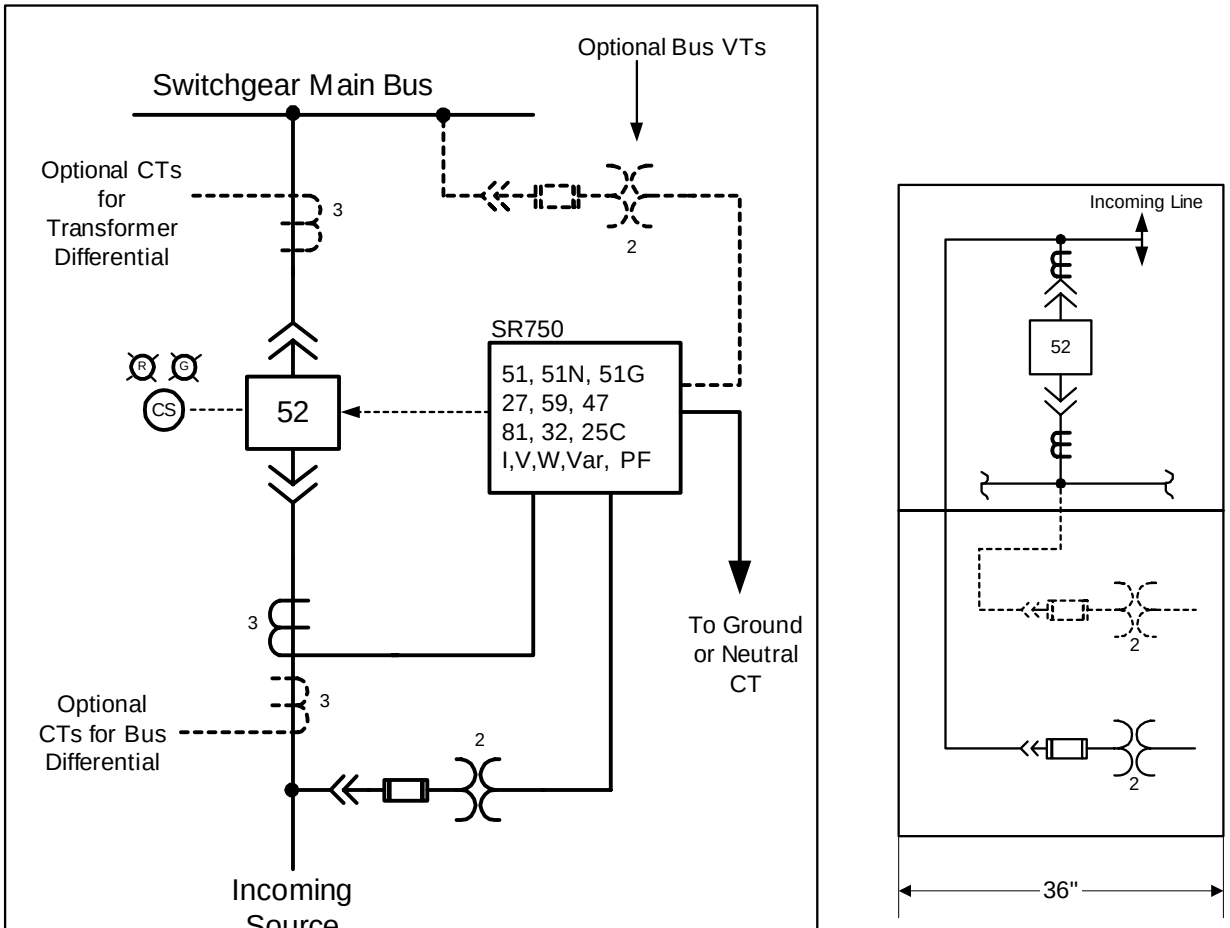
CONTROL VOLTAGE —Available control voltages are 48VDC, 125VDC, 250VDC, 120VAC and 240VAC. For AC control, if a reliable 120/240VAC source is not available at the site, then include a control power transformer connected to each incoming line in each lineup, plus an auto-charged, capacitor-trip device for each circuit breaker and each lockout relay (86) in the lineup. For dual sources with normally open-tie circuit breaker and ac control, add CPT throwover contactor.

REMOTE CONTROL — For circuit breakers controlled from a remote location, choose the remote control scheme for those listed in Table 5-1 (page 5-7 of this guide). From this table, Scheme C is recommended, since it provides maximum operating flexibility. It requires the use of a breaker position switch in conjunction with the breaker control switch to provide the permissive function. With Scheme C, remote close and trip is possible only with the breaker in the "connected" position; local close with the breaker in the "test" position; and local trip with the breaker in the "connected" or "test" position.

Location of Optional Devices

If several optional devices are added to an incoming line section, there may not be sufficient space to mount them all. In this case, specify excess relays to be mounted on the tie-breaker vertical section or on an adjacent auxiliary compartment.

Figure 6-4 Single Source Incoming Line



DUAL SOURCE INCOMING LINES

DEFINITION

Dual source incoming line equipment (DSIL) is a metalclad section containing a power circuit breaker acting as is a main disconnect between a main power distribution bus, and one of two sources of power supplying the main bus. The other source of power may be either another incoming line or a local generator. Both sources supply a common distribution bus, with or without a normally closed bus-tie breaker.

BASIC EQUIPMENT SELECTION

DSIL-1 Use this type of incoming line for an impedance or solidly grounded system fed from a local wye-connected power transformer, with a current transformer in the transformer neutral connection.

This type of incoming line equipment includes three phase-overcurrent relays (51) and three directional phase-overcurrent relays (67). It includes one ground-overcurrent relay, (51G) connected to the neutral CT of a local power transformer feeding the incoming line and one residually connected directional ground-overcurrent relay (67N), polarized from the power transformer neutral CT. These protective functions are available in a single relay package, such as the GE SR750, F650 or F60 relays.

DSIL-2 Use this type of incoming line for an impedance or solidly grounded system fed from a remote wye-connected power transformer.

This type of incoming line equipment includes three phase-overcurrent (51) and directional phase-overcurrent (67). It also includes residual connected ground-overcurrent (51G) and residually connected directional ground-overcurrent (67N) polarized from a wye-broken delta auxiliary VT connected to a set of wye-wye VT's. These protective functions are available in a single relay package, such as the GE SR750, F650 or F60 relays.

DSIL-3 Use this type of incoming line for ungrounded systems only.

This type of incoming line equipment includes three phase-overcurrent (51) and directional phase-overcurrent relays (67), no ground fault detection. These protective functions are available in a single relay package, such as the GE SR750, F650 or F60 relays. There are additional functions available as required.

OPTIONAL EQUIPMENT SELECTION

Protection

OVERCURRENT RELAY CHARACTERISTICS — Time current characteristics for overcurrent relays are determined by system studies. After the time current characteristic has been established, make sure the relays selected offer the required time current characteristics that satisfy the application.

OPEN-PHASE PROTECTION — For incoming lines fed from transformers with fused primaries or sources subject to single-phase operation, add negative-sequence voltage protection (60) and timer (62), as well as current-balance detection (60C), to distinguish which incoming line has single-phase operation.

TRANSFORMER AND BUS DIFFERENTIAL PROTECTION — Add relays and current transformers to obtain this protection, using the same considerations as for single source incoming lines.

DIRECTIONAL POWER, UNDERFREQUENCY, AND UNDERVOLTAGE PROTECTION — Add separate relays or enable these functions in multifunction relays to obtain this protection using the same considerations as for single source incoming lines.

Indication

INSTRUMENTATION AND METERING — For circuits requiring the indication or metering of additional electrical quantities, add indicating analog meters as appropriate, or a multifunction meter such as GE Type PQM II. Some relays also in-

clude extensive metering functions such as Amps, Volts, Watts, Vars, PF and demand functions (such as GE's SR750/760 &, F650).

TEST BLOCKS — For circuits that require the provisions for insertion of portable recording meters or other similar devices, add current and voltage test block. Basic test block is wired to maintain the circuit when the test plug is removed.

INDICATING LAMP— Additional indicating lamps can be provided, such as for circuits requiring a circuit breaker disagreement or spring-charged indication function.

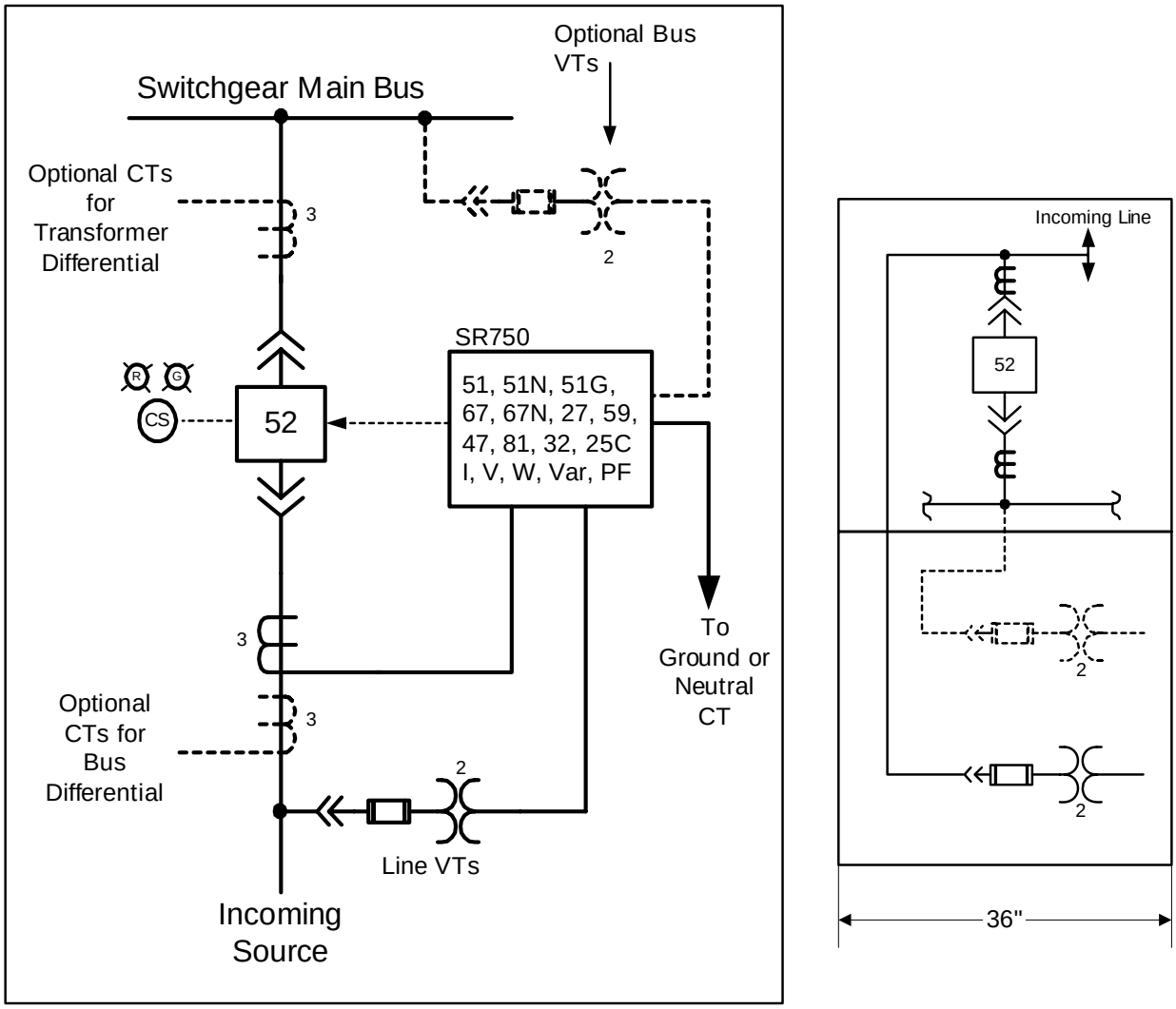
Control

Optional feature involving control voltage and permissive control switch are the same as for single-source incoming line equipments.

Location of Optional Devices

If several optional devices are added to an incoming line equipment, there may not be sufficient space to mount them all. In this case, specify excess relays to be mounted on the tie-breaker vertical section, or on an adjacent auxiliary compartment.

Figure 6-5 Dual Source Incoming Line



BUS TIES

DEFINITION

A bus-tie is metalclad equipment connecting two power distributions buses through a tie breaker. Such equipment is sometimes specified without overcurrent relays because of the difficulty of obtaining selective system operation when using bus-tie over-current relays.

BASIC EQUIPMENT SELECTION

Basic bus-tie circuit breaker and auxiliary bus is located in the bottom compartment of each of two vertical sections. The top compartment of either or both vertical sections can be used as either an auxiliary compartment or a feeder compartment. See Figure 6-15 for arrangement restrictions when selecting Bus Tie equipment.

The basic equipment included in a bus-tie is a circuit breaker control switch and indicating lights.

OPTIONAL EQUIPMENT SELECTION

Protection

OVERCURRENT PROTECTION — For systems requiring overcurrent protection relays for bus-tie equipment, specify incoming line overcurrent relay(s) (50/51) to be wired for a summation current connection. If residually connected ground-overcurrent relays (51N) are required with an incoming line, the equipment may be wired also for a summation current connection. Include a second set of three current transformers if your system has a second incoming line.

BUS-DIFFERENTIAL PROTECTION — For systems requiring bus-differential protection, relays can be mounted in bus-tie vertical sections. Each set of bus-differential protection includes three phase high-speed bus-differential relays (87B) such as GE Multilin MIB, one Type HEA hand-reset lockout relay (86B), and three current transformers. If the bus-differential relays have been included in the incoming line (SSIL or DSIL) package, then additional relays are not required.

AUTOMATIC THROWOVER — For systems with a normally open bus tie circuit breaker that require automatic throwover, add equipment listed under “Single Source Incoming Line Options” in a auxiliary compartment above one of the bus-tie compartments. The control panel for automatic throwover of CPTs can be placed on a swinging auxiliary panel, above a bus-tie, behind the front door of an auxiliary compartment.

Indication

INSTRUMENTATION —For indication of current, add three current transformers (if no CTs are present for overcurrent relaying), an ammeter, and an ammeter switch, or a digital three phase ammeter.

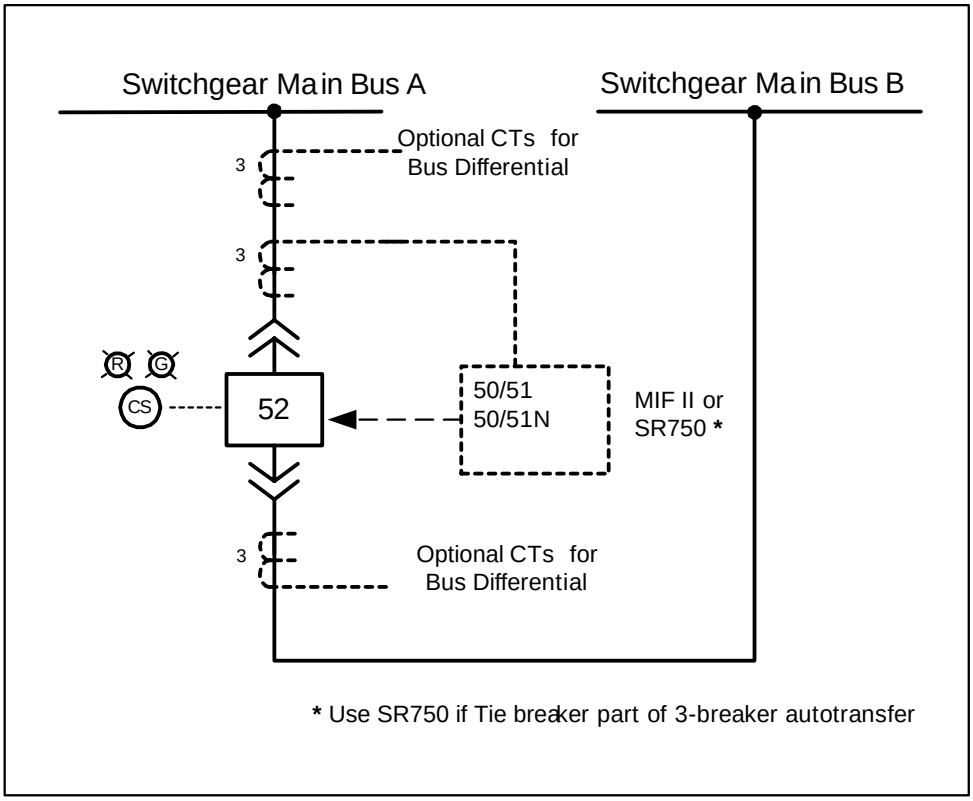
TEST BLOCKS — For circuits that require the provisions for insertion of portable recording meters or other similar devices, add current and voltage test blocks. Basic current test block is wired to maintain the circuit when the test plug is removed.

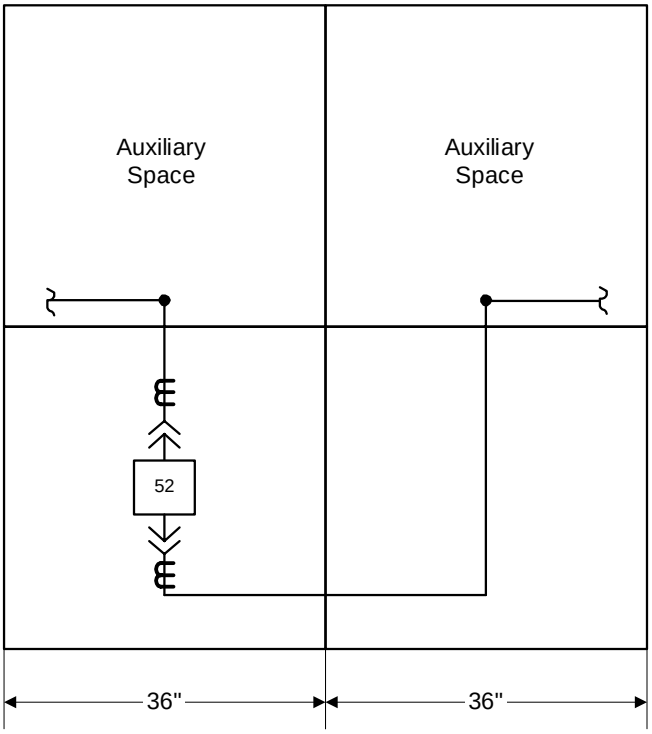
INDICATING LAMP —Additional indicating lamps can be provided, such as for circuits requiring a circuit breaker disagreement or spring-charged indication function.

Control

Optional features involving control voltage and a permissive control switch are the same as for single source incoming line equipment. For circuit breakers where ac control is specified, include a secondary automatic-throwover contactor for control power.

Figure 6-6 Bus Tie





BUS ENTRANCES

DEFINITION

Bus-entrance equipment, also referred to as a cable tap, is a metalclad vertical section in which one of the compartments contains incoming or outgoing conductors which connect directly to the main bus without the use of a circuit breaker. Conductors can be either cables or non-seg bus duct.

BASIC EQUIPMENT SELECTION

Select this type of equipment as a means to connect either incoming or outgoing conductors directly to the bus for circuits that require no circuit breakers. See Section 1 and Figure 6-15 for configuration restrictions when selecting Bus Entrances.

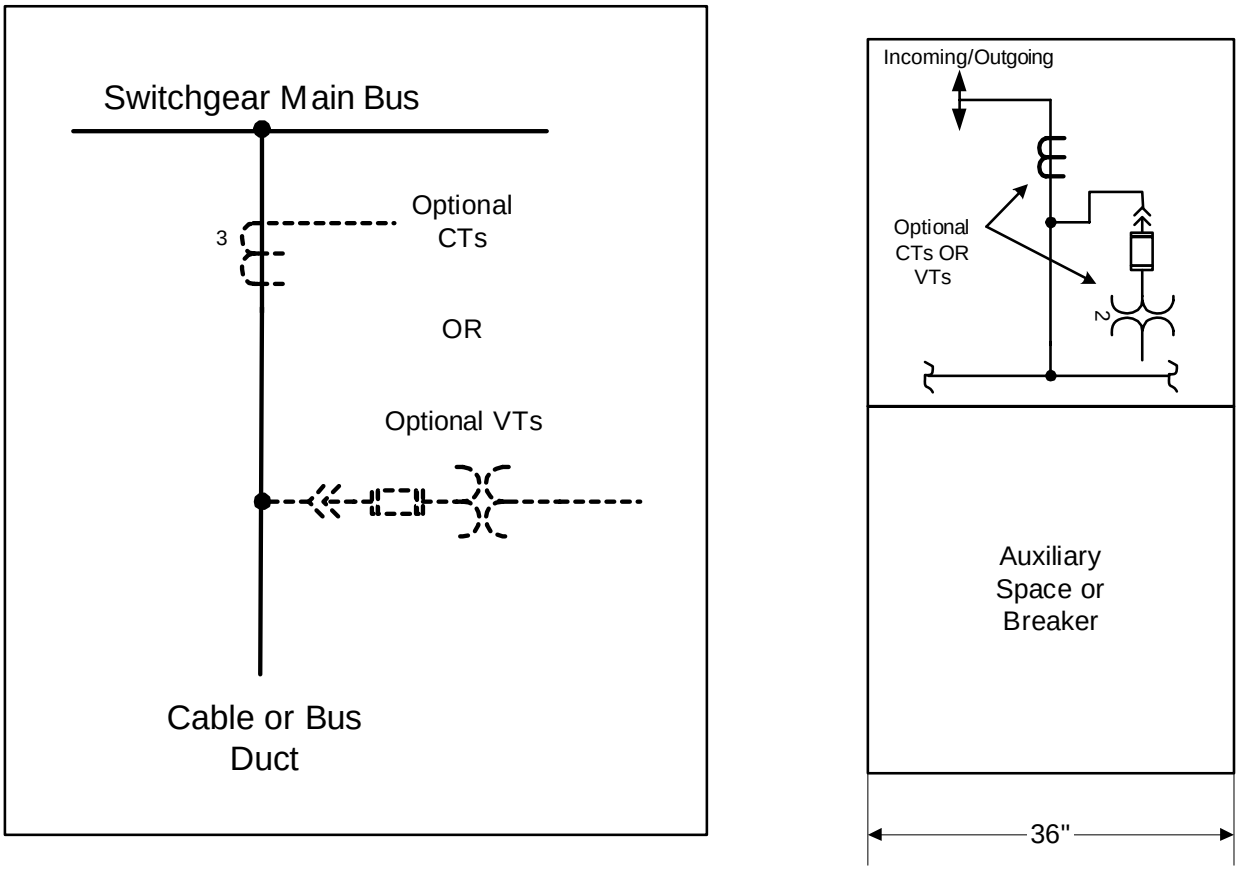
OPTIONAL EQUIPMENT SELECTION

Indication

INSTRUMENTATION AND METERING - For circuits requiring the indication or metering of electrical quantities, add three current transformers or two voltage transformers. Cannot locate both a set of CTs and VTs in a Bus Entrance. Select instrumentation and metering required as necessary.

TEST BLOCKS - For circuits that require the provisions for insertion of portable recording meters or other similar devices, add current and voltage test blocks. Basic current block is wired to maintain the circuit when the test plug is removed.

Figure 6-7 Bus Entrance



INDUCTION MOTOR FEEDERS, FULL-VOLTAGE-START,

DEFINITION

These metalclad feeder equipments (IMF) are used for controlling and protecting full-voltage-start motors and are designated as "branch circuit" protective equipment. Economics usually preclude protecting a motor smaller than 1500 hp (IMF1) with a device package as complete as that used for larger motors (IMF2). The equipment is specified for use on impedance grounded or solidly grounded systems. See "Optional Equipment Selection" for modifications of this equipment for use on systems with other types of grounding. Also see IEEE C37.96-2000 IEEE Guide for AC Motor Protection for relaying recommendations.

PROTECTIVE SCHEME SELECTION

IMF1

Basic equipment for and IMF1 includes three-phase running overload, locked rotor, and short-circuit protection (49/50); undervoltage protection with time delay (27, 62) (only one required per lineup); zero-sequence ground-fault protection (50GS); and load current indication. The overcurrent relays operate from a three CT's, one in each phase, and a ground-sensor CT. Complete economical motor protection packages are available in the GE Multilin 269 and 239 digital motor protection relays. For undervoltage protection when using the Multilin 239, add a separate GE Multilin MIV undervoltage relay. When using the Multilin 269, specify the optional MPM module, or add a separate MIV relay as noted above.

IMF2

Basic equipment for an IMF2 is a GE Multilin SR469 digital motor protection relay which includes (26/50/83) for locked rotor and short-circuit protection; over temperature (49); undervoltage with time delay (27, 62); 3-phase self-balancing machine differential (87M); one Type HEA lockout relay (86M); zero-sequence ground fault (50GS); and full function metering. Additional protective functions are available in the SR469. The Multilin SR469 relay operates from three current transformers, one in each phase, a ground sensor CT and three current transformers located at the motor.

IMFE

These metalclad feeder equipments (IMFE) are used for controlling and protecting full-voltage-start, essential-service motors and are designated as motor "branch circuit" protective equipment. Such motor feeders sound an alarm only for motor overload, but trip the circuit breaker for locked rotor and short-circuit conditions. Basic equipment for an IMFE include a GE Multilin 239 digital motor protection relay which provides three-phase overload indication, locked-rotor tripping, short-circuit tripping (49/50/83), zero-sequence ground-fault protection and load current indication. No undervoltage protection is included. The Multilin 239 relay operates from three current transformers, one in each phase, and a ground sensor CT

OPTIONAL EQUIPMENT SELECTION (For IMFE, IMF1, IMF2)

Protection

For ungrounded systems, omit the ground-sensor overcurrent relay and the current transformer.

When equipment is used to feed more than one motor from the same bus, only one GE Multilin MIV undervoltage relay is required. However, for multiple motors, add auxiliary relay(s) (27X), with sufficient contacts to trip each additional motor feeder breaker.

On smaller motors, where economically justified to include motor differential protection, add one GE Type 12HFC23, 3-element, instantaneous overcurrent relay operating from the three current transformers (mounted at the motor terminals) and

connected for balanced-current motor differential protection (87M).
For larger motors (greater than 1500HP), complete protection including motor differential can be obtained by using the GE Multilin SR469 relay (with motor mounted CTs).

The CT's located at the motor and used for the motor differential (87M) circuit, are typically furnished by the motor manufacturer. They are not supplied with the switchgear.

For lineups with bus differential protection, add three current transformers.

For motors with RTDs, the GE Multilin 469, 369, 269+ and 239 digital motor protection relays offer RTD sensing inputs.

Indication

INSTRUMENTATION AND METERING - For circuits requiring the indication or metering of additional electrical quantities, and using the Multilin 269+, add the MPM module. For circuits without metering built into the multifunction protective relay, add a GE PQM II power quality meter which includes indication of all three phases of current, in addition to Volts, Watts, Vars, PF and demand functions.

TEST BLOCKS - For circuits that require the provisions for insertion of portable recording meters or other similar devices, add current and voltage test blocks. Basic current test block is wired to maintain the circuit when the test plug is removed.

INDICATING LAMP - For circuits requiring a circuit breaker disagreement or spring-charged indication function, add a white indicating lamp.

Control

REMOTE CONTROL — For circuit breakers controlled from a remote location, choose the remote control scheme from those listed in Table 5-1 (page 5-7 of this guide). From this table, Scheme C is recommended, since it provides maximum operating flexibility. It requires the use of a breaker control switch to provide the permissive function. With Scheme C, remote close and trip is possible only with the breaker in the "connected" position; local close with the breaker in the "test" position; and local trip with the breaker in the "connected" or "test position.

In addition, remote control for motors requires a lockout relay (86), which prevents breaker closing (after a relay-initiated trip) until the lockout device is manually reset. (The 86 device specified on IMF2 may be used for both 87M and remote control.)

Location of Optional Devices

If several optional devices are added to a motor feeder equipment, there may not be sufficient space to mount them all. In this case, specify that the excess relays are to be mounted on an adjacent auxiliary compartment. This makes the vertical section a custom section.

Reduced Voltage Starting

Power distribution system voltage regulation requirements sometimes mandate reduced current starting to minimize the current inrush and voltage sag when starting large motors. Inserting a reactor and then bypassing it as the motor comes up to speed is one method of accomplishing this objective.

An auto transformer connection is an alternate method of reduced voltage starting. This method applies a reduced voltage via the autotransformer, which is shorted out as the motor comes up to speed.

Figures 6-9 through 6-10 illustrate the typical POWER/VAC circuits and arrangements for these special motor starting requirements.

Figure 6-8 Induction Motor Feeder

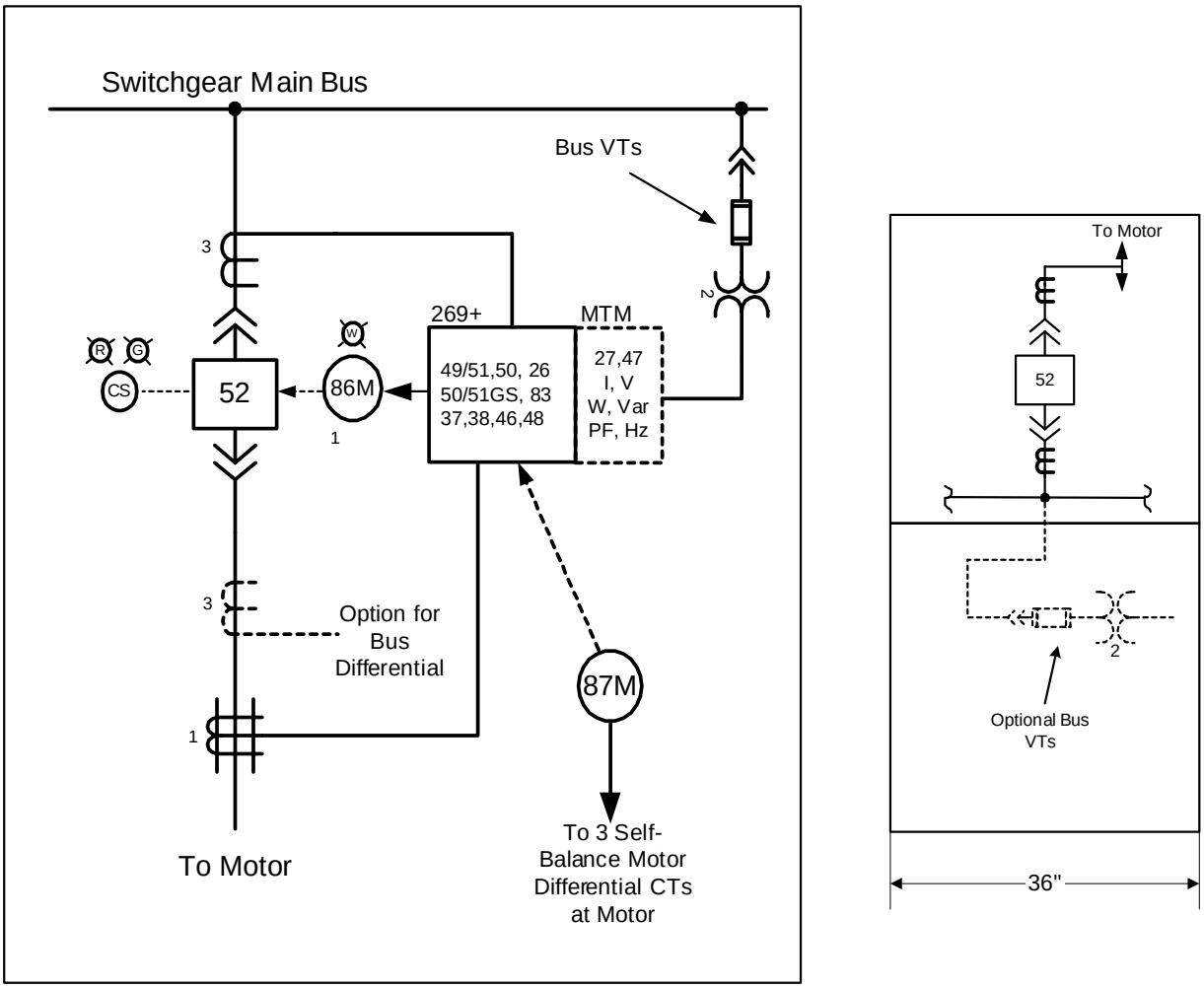


Figure 6-9 IMF, Reduced Voltage Reactor Start

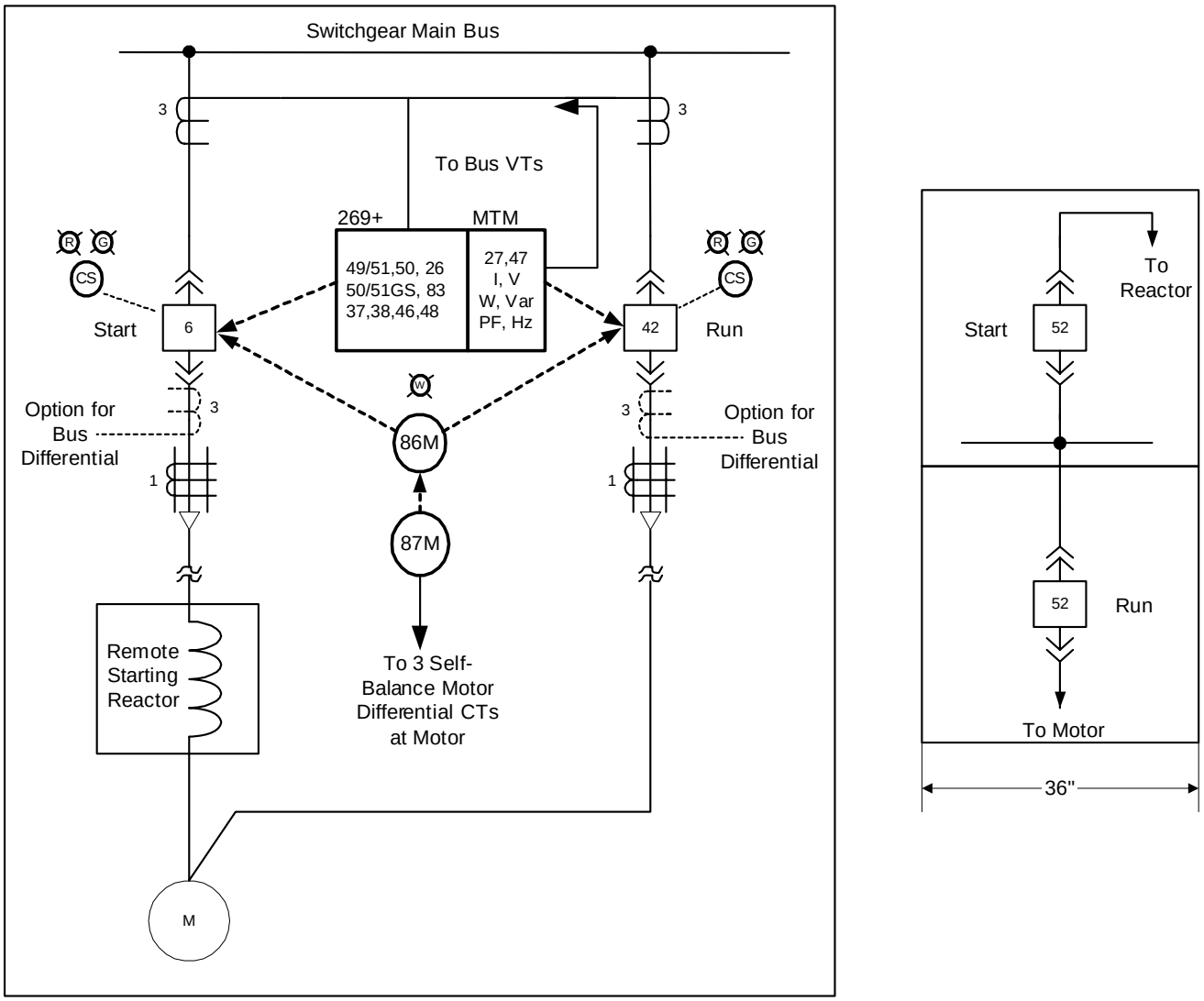


Figure 6-10 IMF Reduced Voltage Autotransformer Start

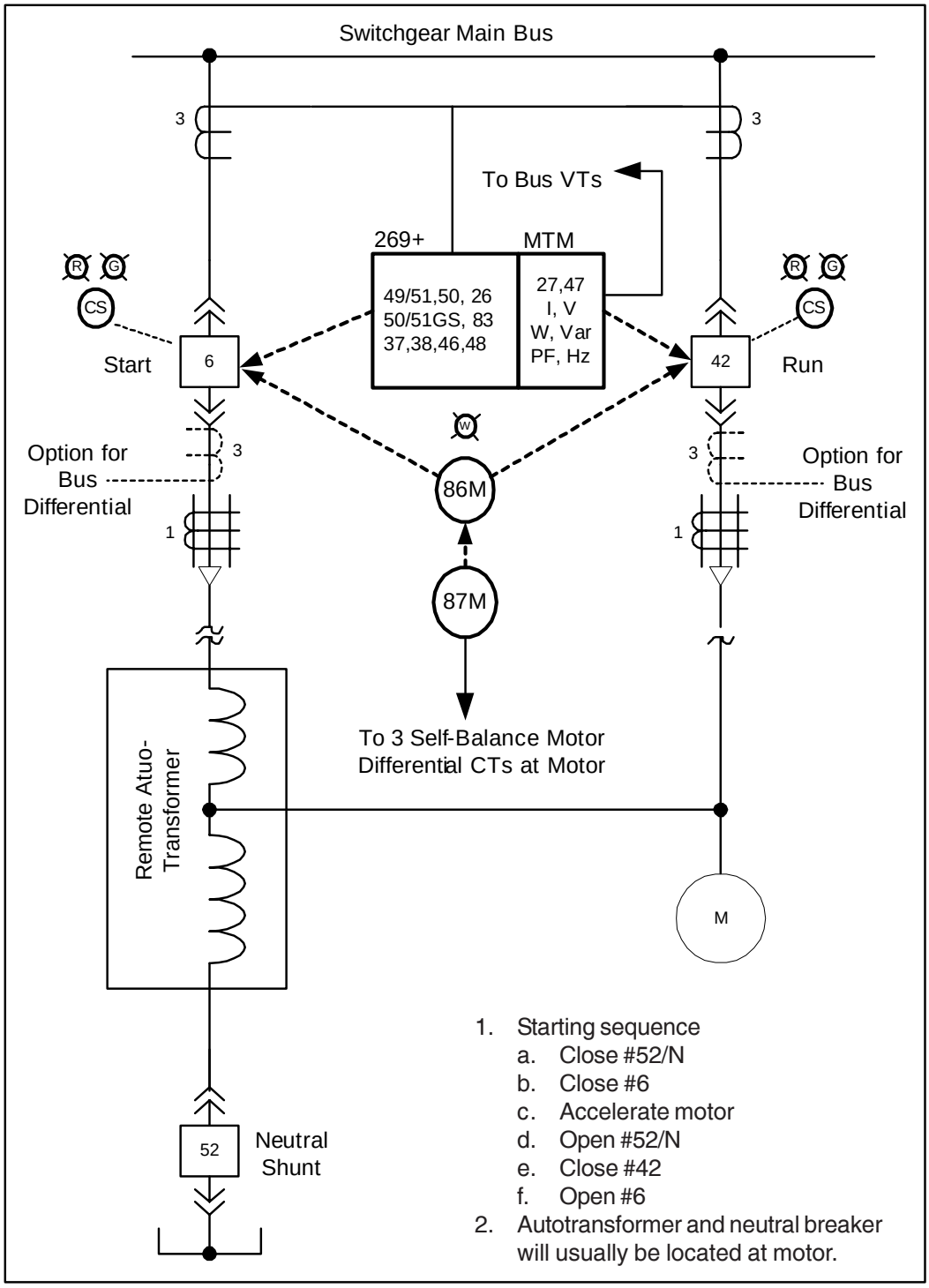
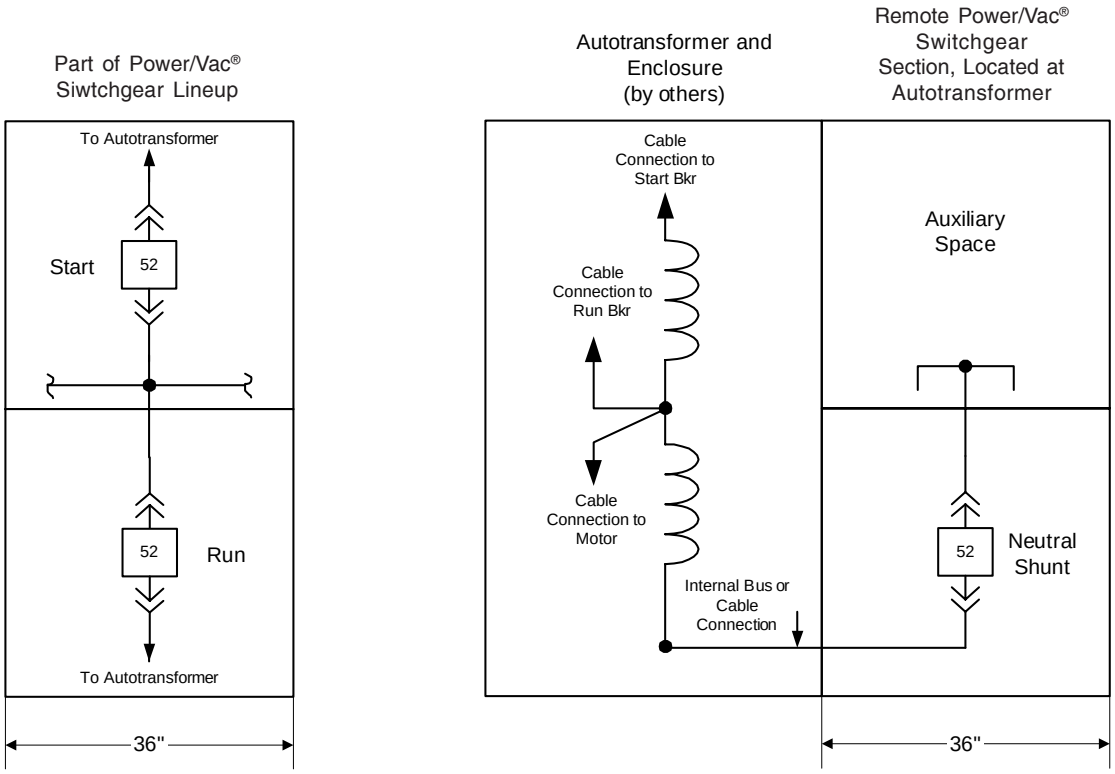
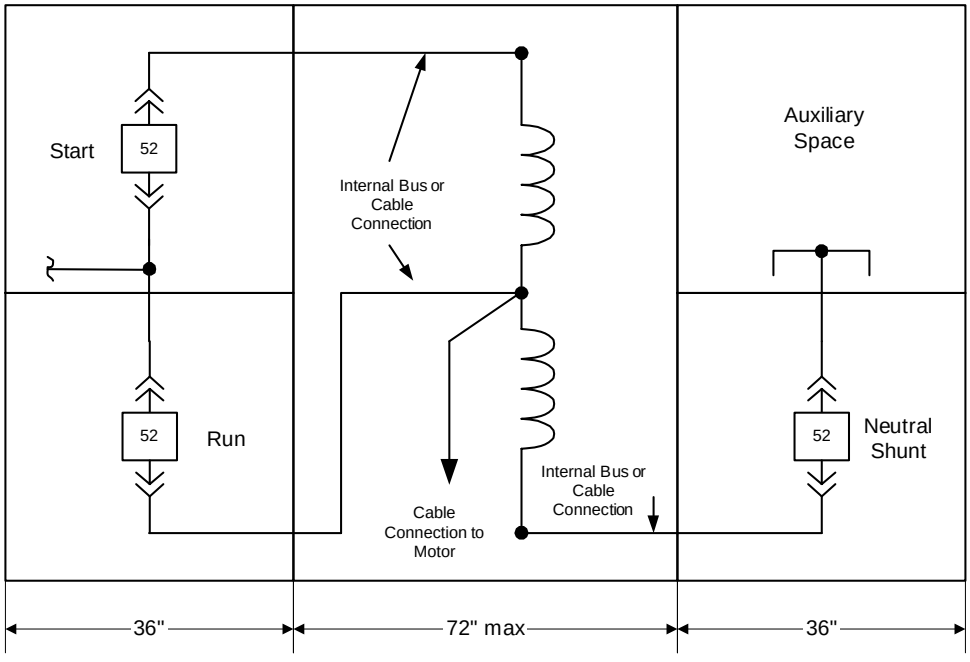


Figure 6-11 Remote Mounted Autotransformer (Standard)



Autotransformer Mounted in Custom Switchgear Section



This option only available for small auto transformers. No extension of main bus available for future add-on.

SYNCHRONOUS MOTOR FEEDERS, FULL-VOLTAGE START, DIRECT-CONNECTED EXCITERS

DEFINITION

These metalclad feeder equipments (SMF) are used for controlling and protecting full-voltage-start synchronous motors and are designated as motor "branch circuit" protective equipment. Economics usually preclude protecting a motor smaller than 1500 hp (SMF1) with a device package as complete as that used for larger motors (SMF2). Also see IEEE C37.96-2000 IEEE Guide for AC Motor Protection for relaying recommendations.

PROTECTIVE SCHEME SELECTION

SMF1

Basic equipment for and SMF-1 (1500 HP and less) includes three-phase running overload, locked rotor, and short-circuit protection (49/50); undervoltage protection with time delay (27, 62) (only one required per lineup); zero-sequence ground-fault protection (50GS); load current indication. The overcurrent relays operate from a three CT's, one in each phase, and a ground-sensor CT. Complete economical motor protection package is available in the GE Multilin 469 digital motor protection relay.
The equipment is specified for use on impedance grounded or solidly grounded systems. See "Optional Equipment Selection" for modifications of this equipment for use on systems with other types of grounding or having motors with other types of excitation.

SMF2

Basic equipment for an SMF2 (greater than 1500 HP) is a GE Multilin SR469 digital motor protection relay which includes three-phase running overload, locked rotor, and short-circuit protection (49/50); undervoltage protection with time delay (27, 62) (only one required per lineup); 3-phase self-balancing machine differential (87M); one Type HEA lockout relay (86M); zero-sequence ground fault (50GS); and full function metering. Additional protective functions are available in the SR469. The Multilin SR469 relay operates from three current transformers, one in each phase, a ground sensor CT and three current transformers located at the motor.

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OPTIONAL EQUIPMENT SELECTION (For SMF1 and SMF2)

Protection

If six-CT machine differential relaying (87M) is desired, omit the three-phase Type 12HFC23 instantaneous relay (if used) and three CT's (supplied by motor manufacturer) at the machine terminals. Use the SR469 relay and six CT's (three in machine neutral leads and three in metalclad switchgear.) Specify the SR469 relay be wired for current summation differential in lieu of self-balance.

For starting control, synchronization and enhanced protection in collector-ring and brushless type motors, add the GE Multilin SPM relay.

For ungrounded systems, omit the ground-sensor overcurrent relay (50GS) and the current transformer.

When equipment is used to feed more than one motor from the same bus, only one GE Multilin MIV undervoltage relay is required. However, for multiple motors, add auxiliary relay(s) (27X), with sufficient contacts to trip each additional motor feeder breaker.

On smaller motors, where economically justified to include motor differential protection, add one GE Type 12HFC23, 3-element, instantaneous overcurrent relay operating from the three current transformers (mounted at the motor terminals) and connected for balanced-current motor differential protection (87M).
For larger motors (greater than 1500HP), complete protection including motor differential can be obtained by using the GE Multilin SR469 relay (with motor mounted CTs).

Excitation

Field application equipment or exciter packages for a synchronous motor are typically furnished with the motor package. Excitation packages and panels can be sourced and mounted in a switchgear compartment or section. These application panels are considered custom design.

Indication

INSTRUMENTATION AND METERING – The GE Multilin 469 provides extensive metering capabilities. For circuits requiring additional or separate metering, add a GE PQM II power quality meter which includes indication of all three phases of load current, in addition to Volts, Watts, Vars, PF and demand functions.

TEST BLOCKS - For circuits that require the provisions for insertion of portable recording meters or other similar devices, add current and voltage test blocks. Basic current test block is wired to maintain the circuit when the test plug is removed.

INDICATING LAMP - For circuits requiring a circuit breaker disagreement or spring-charged indication function, add a white indicating lamp.

Control

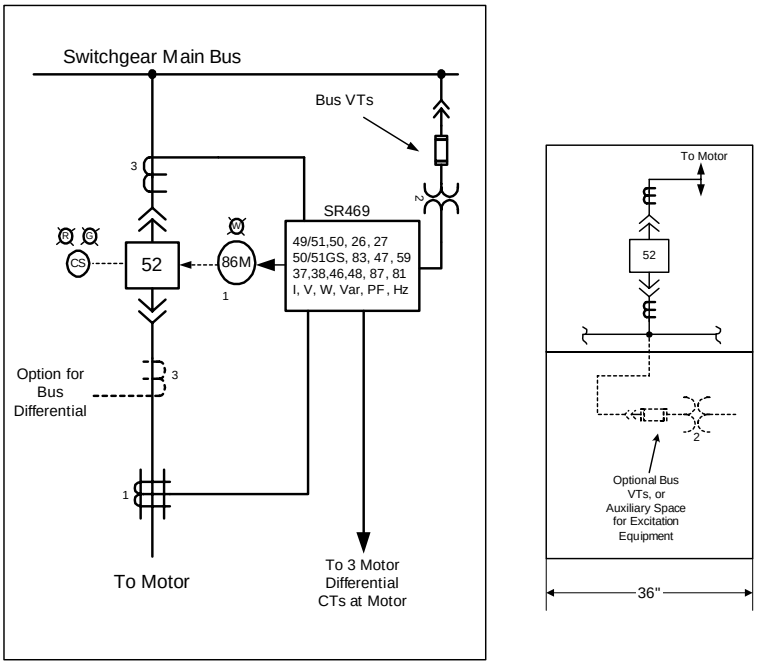
REMOTE CONTROL - For circuit breakers controlled from a remote location, choose the remote control scheme from those listed in Section 5, Table 5-1. From this table, Scheme C is recommended, since it provides maximum operating flexibility. If requires the use of a breaker position switch in conjunction with the breaker control switch to provide the permissive function. With Scheme C. remote close and trip is possible only with the breaker in the “connected” position; local close with the breaker in the “test” position; and local trip with the breaker in the “connected” or “test” position.

In addition, remote control for motors requires a lockout relay (86), which prevents breaker closing (after a relay-initiated trip) until the lockout device is manually reset. (The 86 device specified on SMF2 may be used for both 87M and remote control.)

Location of Optional Devices

If several optional devices are added to a motor feeder equipment, there may not be sufficient space to mount them all. In this case, specify that the excess relays are to be mounted on an adjacent auxiliary compartment. This makes the vertical section a custom section.

Figure 6-12 Synchronous Motor Feeder



GENERATORS

DEFINITION

Generator metalclad equipment (GEN) controls and protects a synchronous generator driven by a steam turbine, gas turbine, a diesel engine, a gasoline engine, a water-wheel turbine, or a motor. The generator may be operated as an isolated system source or in parallel with other power sources. The basic equipment specified here is adaptable to any of these circumstances with the addition of the proper optional equipment. Most generator equipments are custom.

BASIC PROTECTIVE SCHEME

The basic equipment includes no field control or voltage regulator equipment, since this equipment is normally supplied with the generator and located in a separate cubicle either adjacent to the generator or near the switchgear.

Basic GEN protection utilizes the GE Multilin 489 digital generator protection relay, which includes three-phase voltage-restrained overcurrent (51V), ground overcurrent (51G or 50G), reverse power/anti-motoring protection (32) and generator differential (87G). Include one Type HEA lockout relay (86G). The relay operates from three switchgear mounted CT's, one in each phase, three CTs located at the generator (furnished by the generator manufacturer) and a set of VTs connected to the generator side of the circuit breaker.

Field Control and Voltage Regulation

To obtain field control for remote-mounted field application equipment, add one motor-operated rheostat control switch and one field ammeter.

For generators with brushless exciters and without remote SC-VT regulators, add one metalclad equipment vertical section containing provisions for mounting a voltage regulator, brushless exciter field control, mounting for an exciter field rheostat, and an exciter field ammeter. Add one or two VT's and one CT to the generator circuit breaker vertical section for use with the voltage regulator, if required.

Protection

FOR GENERATORS ON GROUNDED SYSTEMS - Use ground overcurrent relay connection (51G).

FOR GENERATORS OPERATING IN PARALLEL WITH OTHER POWER SOURCES ON GROUNDED SYSTEMS - Add one Type DIFC ground relay (51GN). See GER-3011.

FOR LARGE GENERATORS (larger than 5000 kW) - Add loss-of-field relay (40), negative sequence current relay (46), and voltage-balance relay (60). These features are all available in the GE Multilin 489 digital generator protection relay.

Synchronizing

For manual synchronization of machine to bus, specify a synchronizing panel with two voltmeters, a frequency meter, a synchroscope, and two indicating lamps.

For automatic synchronizing, custom packages are available. Contact your GE Representative.

Isolated Systems

Omit the synchronizing switch and add one frequency meter and a voltmeter.

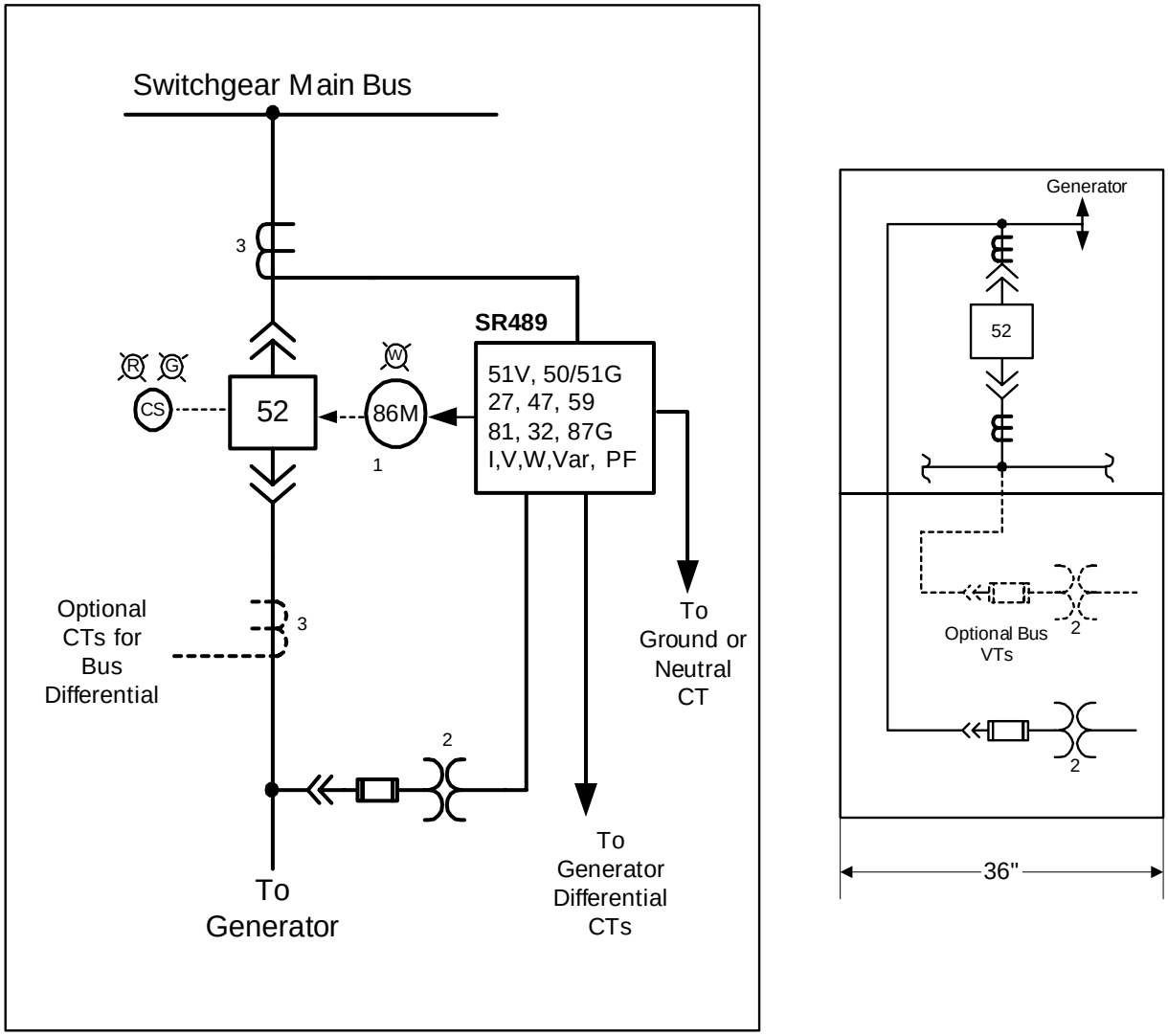
Current Transformers

Add three current transformers for lineups that include bus differential protection.

Indication and Metering

For generators requiring supplementary indication and metering, add one GE Type PQM meter and current or voltage test blocks as required.

Figure 6-13 Generator



POWER COMPANY METERING

DEFINITION

Metalclad equipment that contains Utility owned metering transformers and meters. These sections are custom, and designed to meet the specific requirements of the specified Utility. Sections are dedicated for Utility use, therefore cannot contain any Owner/Customer equipment. Standard designs utilize either 36" wide or 48" wide sections. Some Utilities require a separate cable entry or pull section for the incoming cables, in addition to the metering section. Section designs can be for “Hot Sequence” (metering before main disconnect/breaker) or “Cold Sequence” (metering after main disconnect/breaker) as shown in Figure 6-14.

Consult the serving Utility on your project, for their specific requirements regarding metering section design and construction. All metering section designs must be approved by the Utility, prior to manufacture.

Figure 6-14. Utility Metering Arrangements

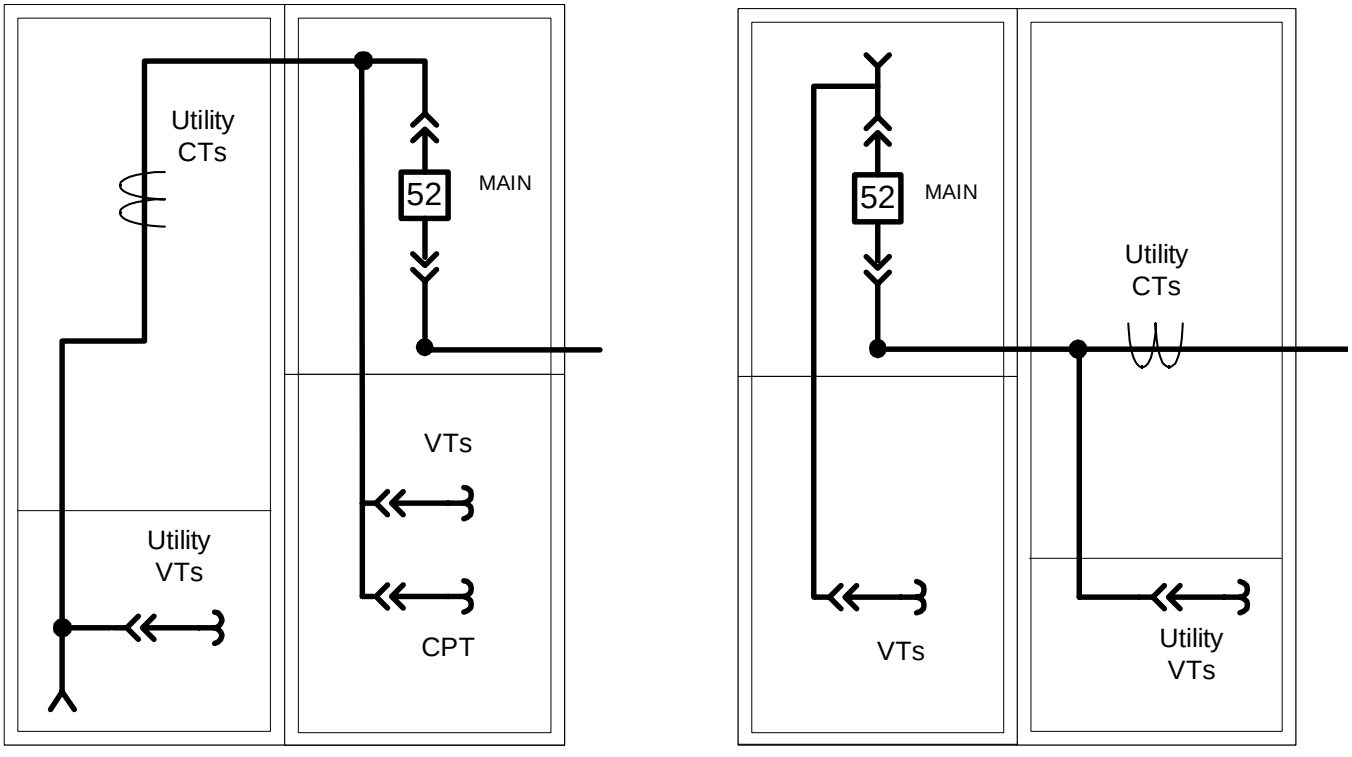
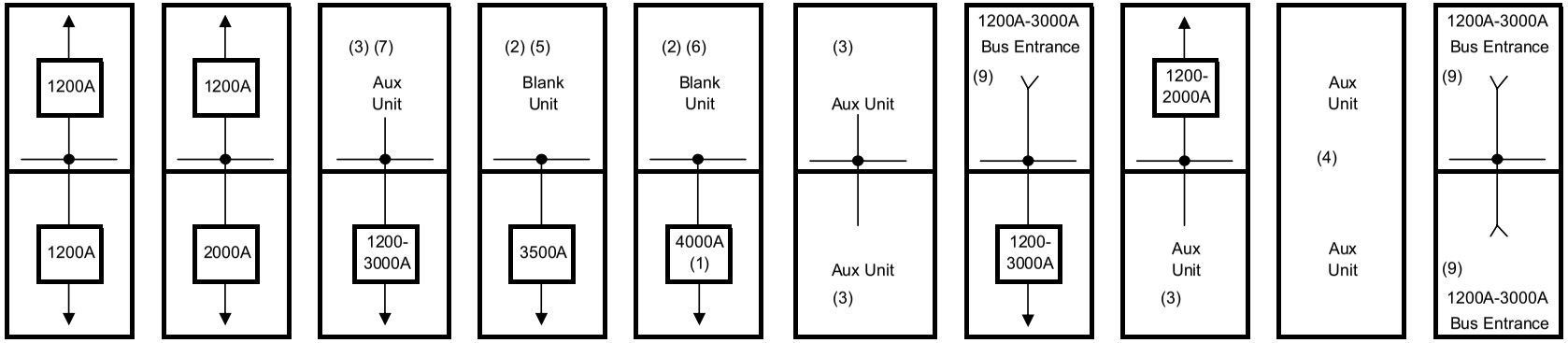
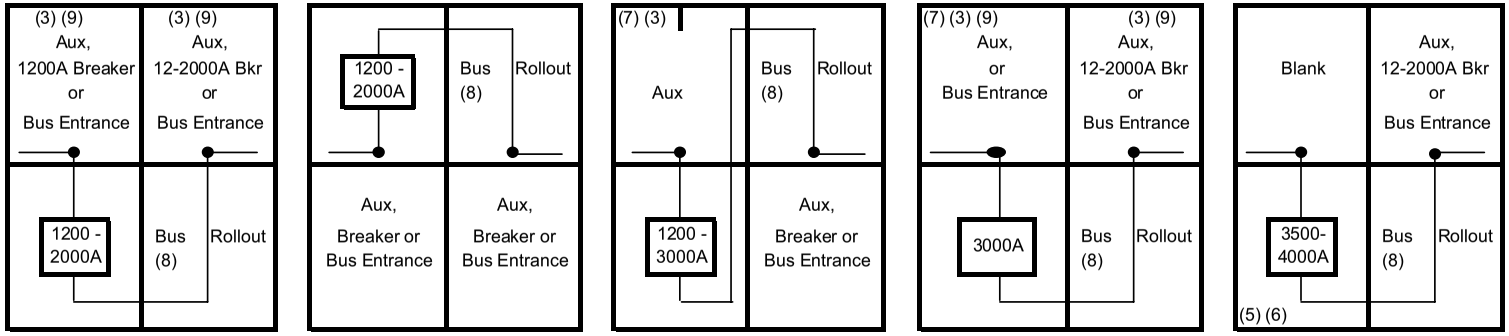


Figure 6-15.

Standard Power/Vac® Breaker Stacking Configurations



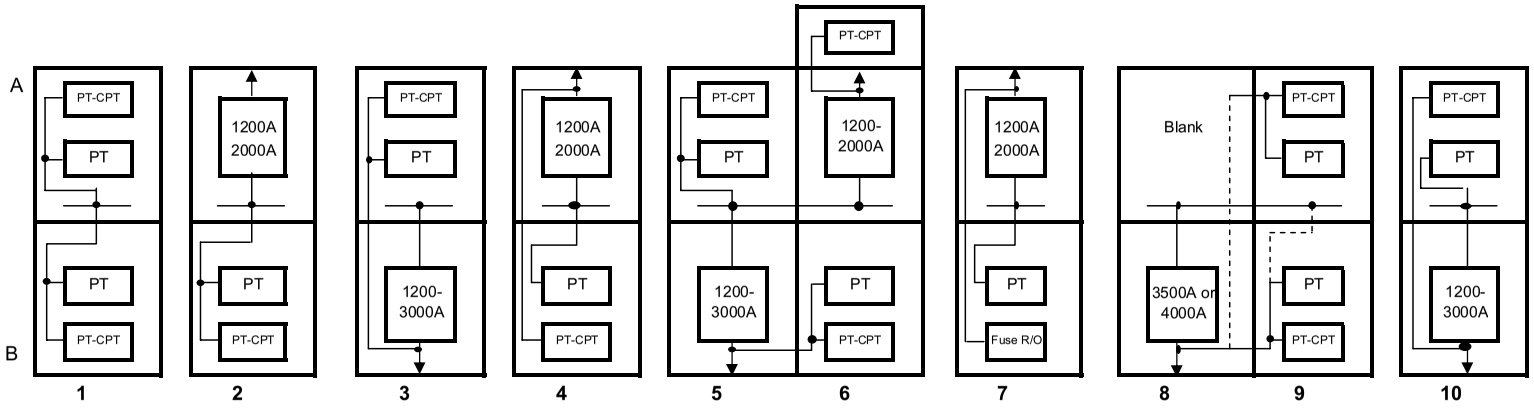
Standard Power/Vac® Bus Tie Breaker Stacking Configurations



(1) 4000A breakers require fans on top of structure for forced air cooling.
(2) Blank Unit above 3500A & 4000A breakers have room for device mounting .
(3) Auxiliary Units can contain rollout tray for VTs & CPTs, or additional device mounting.
(4) Full height Auxiliary Units can contain additional device mounting or be used for material storage .
(5) 3500A must be derated to 3250A in outdoor construction.
(6) 4000A is not available in outdoor construction.
(7) Rollouts located above a 3000A breaker, are only available on indoor construction.
(8) Auxilary Bus Ties can contain 1 bus connected rollout tray.
(9) Bus Entrance can also contain a VT rollout tray, or CTs (not both)

Each section in standard indoor construction is 36" W x 95" H x 94" D.

Figure 6-16.



Standard Power/Vac® Auxiliary Compartment Configurations

1. 4 high auxiliaries capability
2. 1200A/2000A breaker in A, two bus connected rollouts in B
3. 1200A, 2000A or 3000A breaker in B, two line connected rollouts in A (rollouts above 3000A Bkr on indoor construction only)
4. 1200A/2000A breaker in A, two rollouts in B, one line & one bus connected
5. 1200A, 2000A or 3000A breaker in B, two bus connected rollouts in A (rollouts above 3000A Bkr on indoor construction only)
6. 1200A/2000A breaker in A, with line connected rollout in superstructure. Two rollouts in B, line connected from adjacent section (1200A, 2000A or 3000A breaker)
7. 1200A/2000A breaker in A, two rollouts in B, one line connected fused R/O, with large CPT mounted in rear
8. 3500A/4000A breaker in B compartment with line connection to adjacent section 9. A compartment must beblank
9. Two rollouts in A or B compartments, line connected to 3500A/4000A breaker in adjacent section 8, Rollouts can be combination of line or bus connected.
10. 1200A, 2000A or 3000A breaker in B, one line and one bus connected rollouts in A (rollouts above 3000A Bkr on indoor construction only)

NOTE: ALL ROLLOUT TRAYS ARE HARD BUS CONNECTED. NO CABLE CONNECTED TRAYS.

Rollout Unit	Devices	Ratings	A Compartment		B Compartment	
			Lower	Upper	Lower	Upper
VT	2 - VTs (1)	5KV through 15KV	Yes	Yes	Yes	Yes
VT	3 - VTs (1)	5KV through 15KV	Yes	Yes	Yes	Yes
CPT	1 - CPT (1)	5, 10, 15KVA	No	Yes	Yes	No
Fused Unit	1 - CPT (2)	25, 37.5KVA (4)	Yes	N/A	Yes	N/A
Fused Unit	CPT Fuses (3)	Remote 225kVA Max	Yes	N/A	Yes	N/A

(1) Fuses are an integral part of VT or CPT. CPTs are single phase
(2) CPT is installed in the rear cable compartment. CPT fuses are installed in a key interlocked fuse rollout in the Lower A or Lower B compartment
(3) Fused rollout tray must be key interlocked with remote CPT secondary breaker
(4) Contact GE Sales Office for availablity of larger CPTs or 3-phase bank.