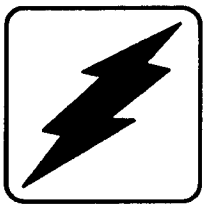
Training Manual

Transfer Switch Controller



Models:
S340
S340+

KOHLER®
POWER SYSTEMS

TP-6003 4/98

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INTRODUCTION

This manual is not to be used for installation or service. It is only intended as an informational training guide for the Kohler S340 series Transfer Switch Controllers and does not necessarily contain all available service and sales information. The Manufacturer reserves the right to make changes to this literature and the products represented at any time without notice and without incurring obligation.

Information found in this publication is based on data available at the time of printing. Manuals are available for service, parts and installation of this equipment from the Kohler Co. Generator Division, Service Parts Department.

TP-5087 OPERATION AND INSTALLATION - S340

TP-5663 OPERATION AND INSTALLATION - S340+

TP-5612 SERVICE S340 LOGIC BOARD

TP-5257 PARTS CATALOG - S340

TP-5671 SERVICE AND PARTS MANUAL - S340+

A generator set and transfer switch, like any other electromechanical device, can pose potential dangers to life and limb if improperly maintained or operated.

Caution, Warning and Danger precautions listed below are included in manuals and on labels attached to equipment.

Please familiarize yourself with this important information.

⚠ DANGER

Danger indicates the presence of a hazard that *will* cause *severe* personal injury, death, or substantial property damage.

⚠ WARNING

Warning indicates the presence of a hazard that *can* cause *severe* personal injury, death, or substantial property damage.

⚠ CAUTION

Caution indicates the presence of a hazard that *will* or *can* cause *minor* personal injury or property damage.

NOTICE

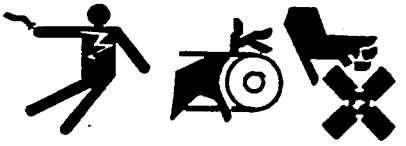
Notice communicates installation, operation, or maintenance information that is important but not hazard related.

Safety decals affixed to the generator set in prominent places advise the operator or service technician of potential hazards and how to act safely. The decals are reproduced in this publication to improve operator recognition. Replace missing or damaged decals.

Safety decals affixed to the transfer switch in prominent places advise the operator or service technician of potential hazards and how to act safely. The decals are reproduced here to improve operator recognition. Replace missing or damaged decals.

Accidental Starting

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set (disconnect negative lead first and reconnect it last).

Disabling generator set. Accidental starting can cause severe injury or death. Turn generator set master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on the generator set or connected equipment. The generator set can be started by an automatic transfer switch or remote start/stop switch unless these precautions are followed.

Making line or auxiliary connections. Hazardous voltage can cause severe injury or death. To prevent the possibility of electrical shock, de-energize the normal power source before making any line or auxiliary connections.

Servicing transfer switch. Hazardous voltage can cause severe injury or death. De-energize both normal and emergency power sources before proceeding. Move generator set master switch on controller to OFF position and disconnect battery negative (–) before working on transfer switch! Turn the transfer switch selector switch to the OFF position.

Servicing transfer inner panel. Hazardous voltage can cause severe injury or death. Disconnect inner panel harness at inline connector. This will de-energize circuit board and logic circuitry but allow transfer switch to continue to supply utility power to necessary lighting and equipment. Hazardous voltage exists for any accessories mounted to inner panel which are NOT wired through the inner panel harness and de-energized by inline connector separation. Such accessories are at line voltage.

KOHLER S340 / S340+

AUTOMATIC TRANSFER SWITCH CONTROL

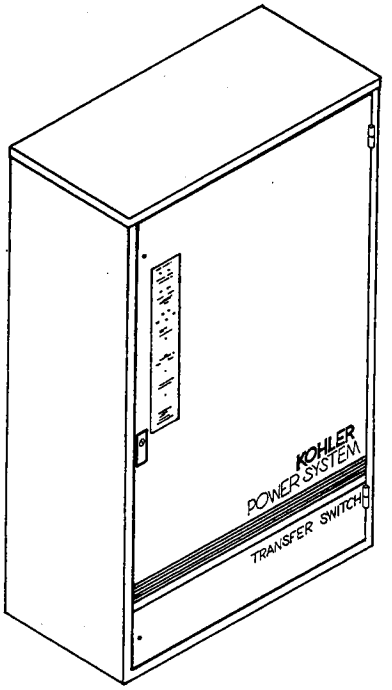
The S340 Series of Automatic Transfer Switches feature Solid State Controllers. These controllers and optional components are located on a panel mounted to the hinged, removable door panel and operate switching mechanisms from 30 to 4000 amperes.

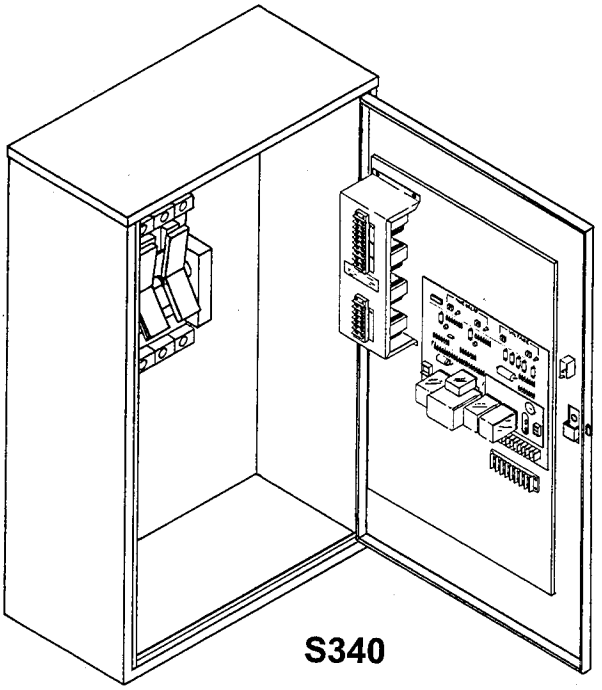
The **S340** Controller was designed for fast action switching mechanisms that perform a transfer from one source to another in 1/6th second or less.

In addition to the many standard features provided with the S340 Controller numerous Accessories are offered.

The Plus version of the S340 **(S340+)** features an interface board which allows customer selection of various power switching devices including circuit breakers and motor starting contactors capable of providing an open or "OFF" position. (PROGRAMMED TRANSITION)

A minimal number of accessory options are offered with the PLUS series.





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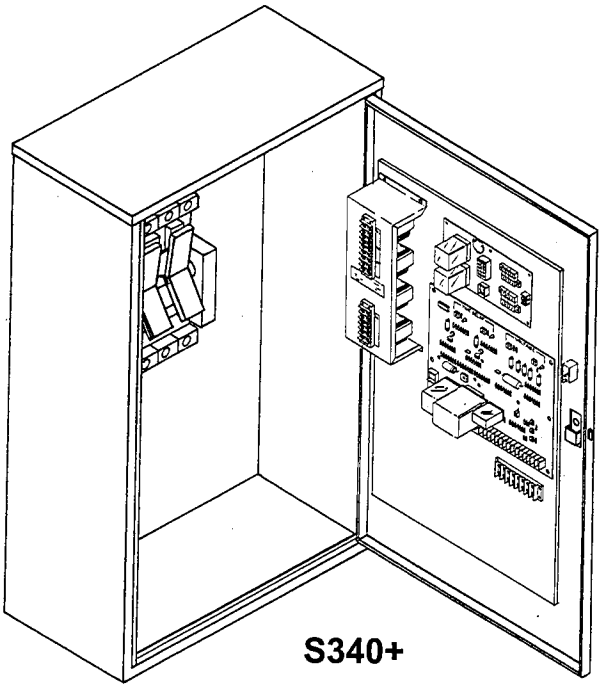
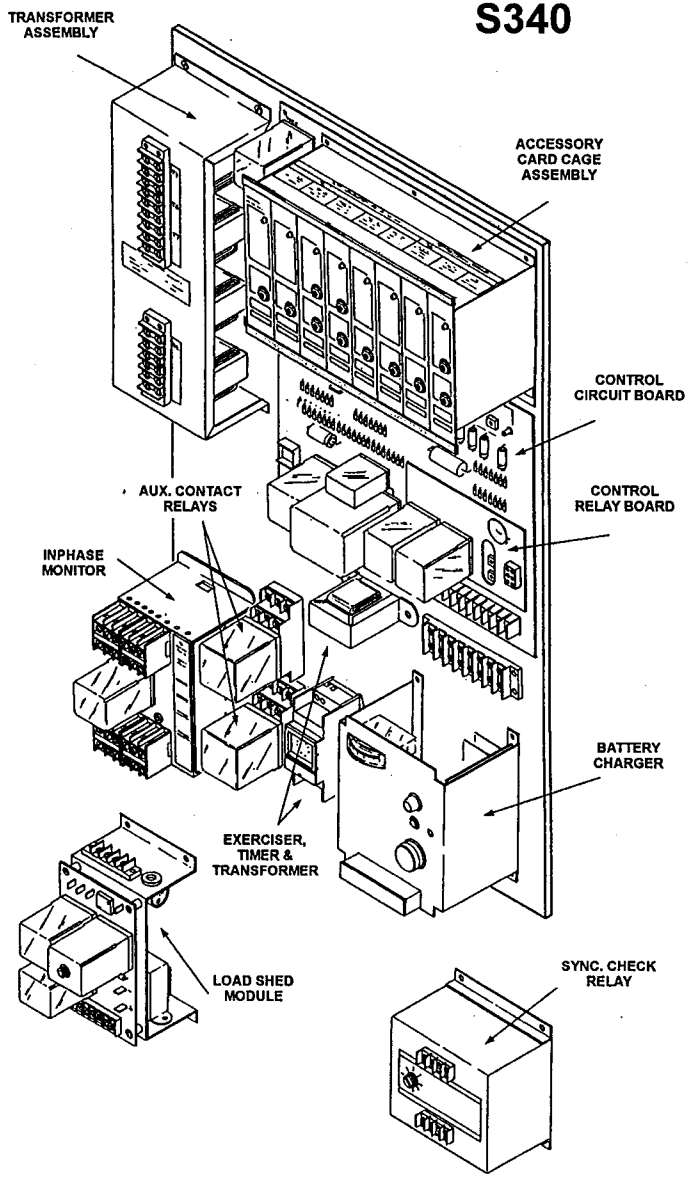


S340+

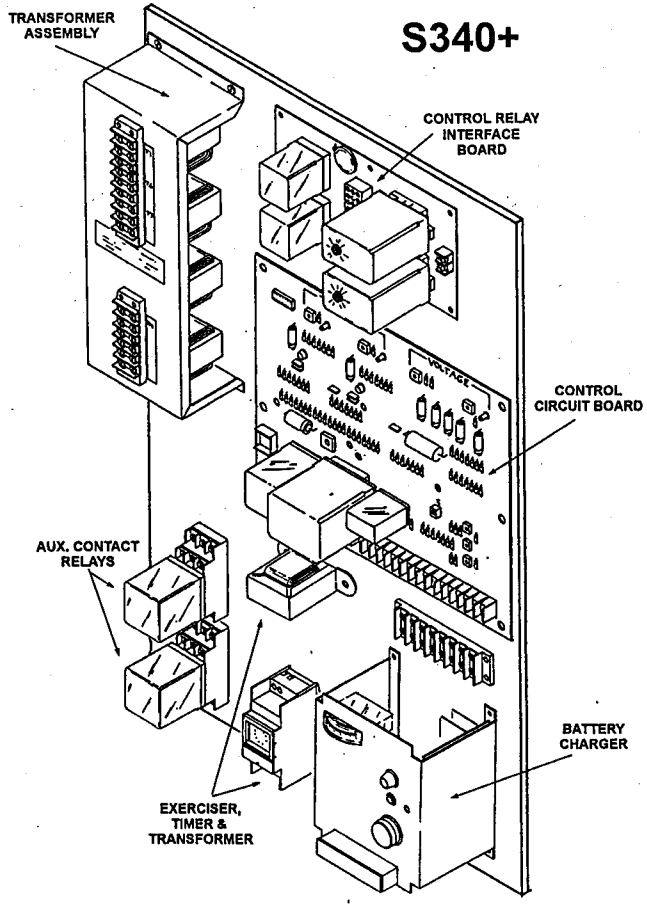
INNER DOOR PANEL

CONTROLLER, POWER TRANSFORMERS
AND OPTIONAL COMPONENT LOCATION.

S340



S340+



CONTROL SWITCHES & INDICATORS

An area on the door panel is allocated for installation of the most commonly used switches and indicators. Knockouts are provided under the nameplate decal to aid in field installation of non-standard switches or indicators.

T/S POSITION / SOURCE AVAILABLE

Lamps that indicate which source is being provided to the load, (Green Normal, Red Emergency) and which source(s) are available (White) are standard on the S340+ transfer switch and optional on the S340.

TEST SWITCH

A normally closed spring loaded toggle test switch is provided as standard.

SELECTOR TEST SW / INDICATOR

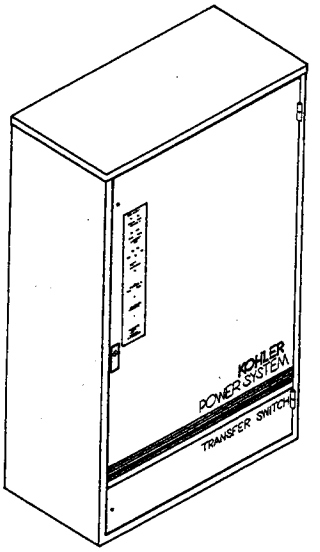
An optional 4 position selector test switch can replace the standard toggle switch and provide an Engine Start only (no transfer) and an Off position to prevent automatic operation of the switch. A white indicator lamp is provided with this option and will light when the switch is not in the "Auto " position.

LOAD / NO LOAD EXERCISER SELECTOR

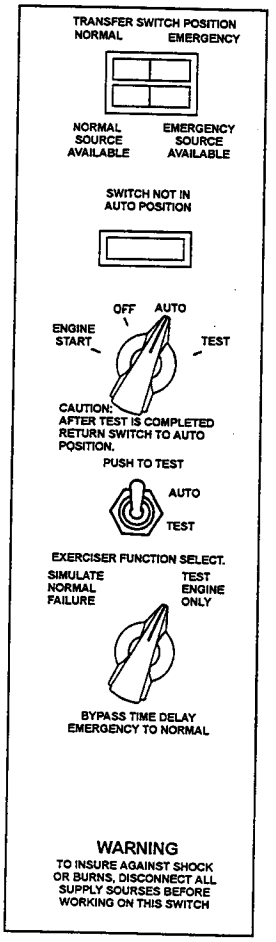
A two position selector switch can also be installed which will allow the option of periodically exercising the Engine/Generator unloaded or cause an actual transfer of the load to the Generator during the exercise period. The switch is part of an exerciser option.

TIME DELAY BYPASS

The delay time on a return transfer from the Emergency source back to the Normal source (TDEN) can be bypassed by the installation of a momentary toggle switch on S340 systems. This can be accomplished on a S340+ logic board by removal of a jumper.



S340+



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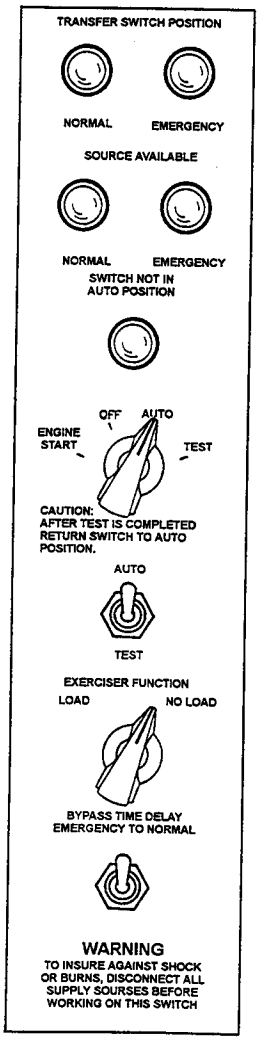
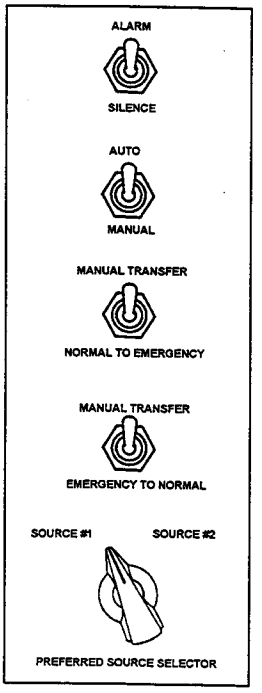


SELECTOR SWITCHES (S340)

Additional Selector switched options can be added to the S340 transfer switch control.



ALARM SILENCE

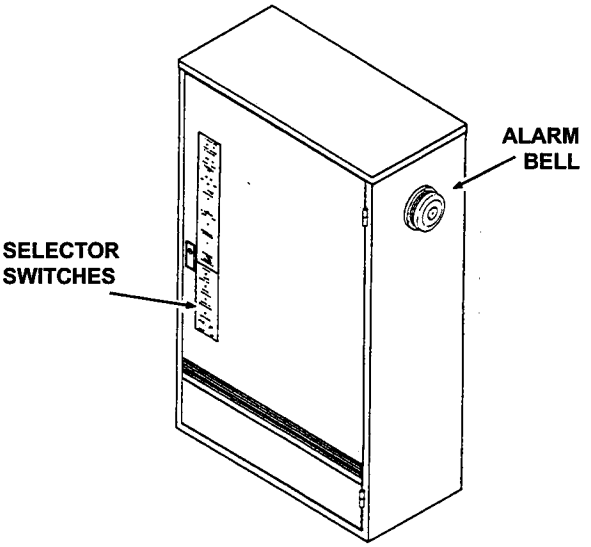
If an Audible Alarm option which indicates the Transfer switch is in the Emergency Position is installed, a toggle switch is provided for silencing the alarm if desired.

AUTO / MANUAL SWITCHES (N to E, E to N)

If it is required to have the option of *manually* causing a load transfer to the alternate source, an Auto/Manual switch and selector switches for transferring from Normal to Emergency and Emergency to Normal can be installed.

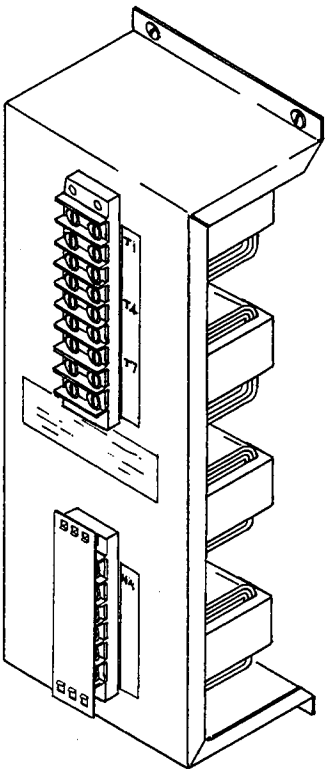
PREFERRED SOURCE SELECTOR SWITCH

Most installations will have a Utility supply for the Normal or preferred source and an Engine/Generator for the Emergency or secondary electrical supply.
If both sources are Utilities or both are Engine /Generator sets one must be designated as the Normal or Preferred source. An optional selector switch may be added to allow operator selection of the Normal (preferred) source.



TRANSFORMER ASSEMBLY

Both Normal and Emergency source voltages to the control circuitry are reduced to 12 and 24 volts by transformer assemblies. These assemblies are interchangeable between panels and can easily be replaced in the field to accommodate any voltage from 110 to 600, both 50 an 60 hertz.



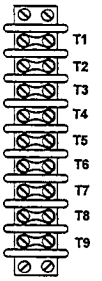
Three transformers designated as NT1, NT2 and NT3 provide control and sensing voltage from phases A,B and C of the Normal source of a three phase system. A single transformer ET1 is standard for sensing and control of the Emergency circuit. 3 Phase sensing of the Emergency source is optional.

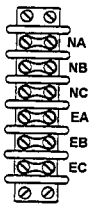
On Single Phase panels one transformer is used on the Normal and one on the Emergency.

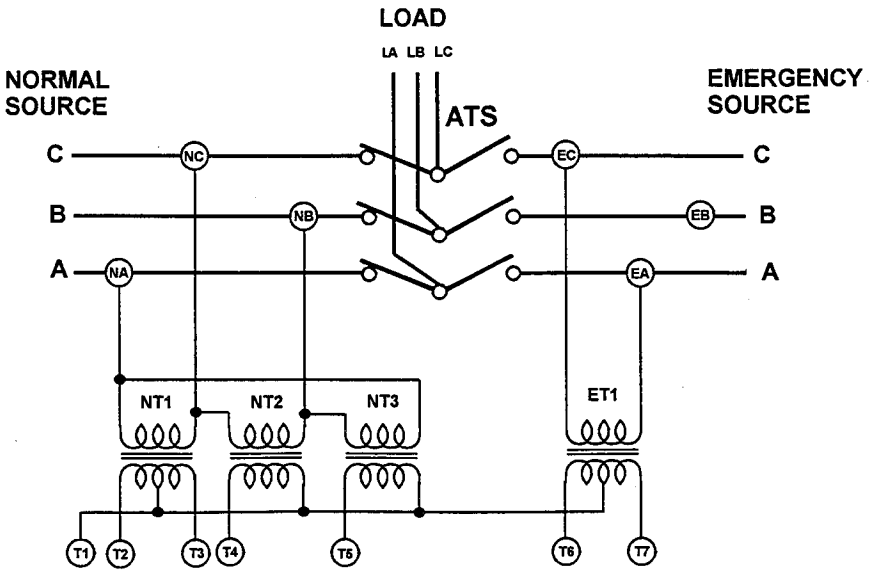
Transformers NT1 and ET1 have center tapped 24 volt secondaries which also provide 12 volts between the center and end turns.

Terminal strips on the transformer housing provide both primary and secondary voltage termination.

Line voltage is present at the primary transformer terminals. A protective barrier cover is factory installed for protection from electrical shock.







S340 SERIES CONTROLLERS

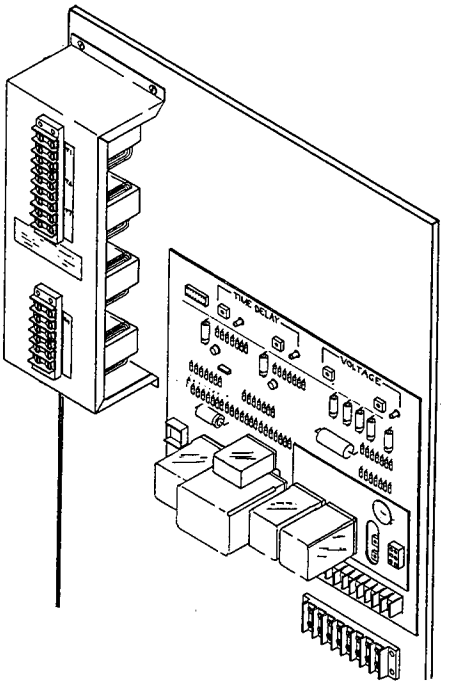
CONTROLLER

The decision making process of the Automatic Transfer Switch is performed by the Controller.

The Controller monitors the Systems Electrical supplies and logically energizes control relays for engine starting and switch transfer. Voltage supply to the transfer mechanism is provided by the source to which the switch is transferring to.

The Controllers are sensitive to the System Voltage and Frequency. Transformers are selected to match the line voltage and provide a 12 and 24 volt input to the sensing and control circuits.

Standard controller features include:



- Adjustable voltage sensing control of the Normal voltage from 72 to 100% of Normal for pick-up and 70 to 98% for dropout.

  The Voltage Sensing circuit is adjustable to allow initiation of a transfer from the Normal to Emergency source if the Normal voltage fails or drops below a preset level of 70 to 98% of Nominal. On a 240 volt system set at 70%, a signal for an engine start would be initiated if the voltage drops below 168 volts. The desired pick-up voltage on return of Normal is also adjustable (72 to 100%). If the pick-up was adjusted at 90% a retransfer would occur when the Normal source returned to approximately 216 volts. An LED is provided to indicate voltage is at the preset pull in level.

- **TDNE** Time Delay on Transfer from Normal to Emergency (adjustable 0.6 to 60 seconds).
  TDNE delays transfer of the switch from the Normal source to the emergency source. This overrides momentary power outages or fluctuations that may occur on the system if the emergency source is another utility, or it allows time for the emergency source to stabilize before accepting the load if the emergency source is a generator set. The timer begins timing when the emergency source appears, but will not transfer to it until the time delay setting has elapsed. A delay of 0 - 30 minutes is optional.

- **EFR** Frequency/voltage relay for the Emergency source, Non-adjustable. Monitors 1 phase only

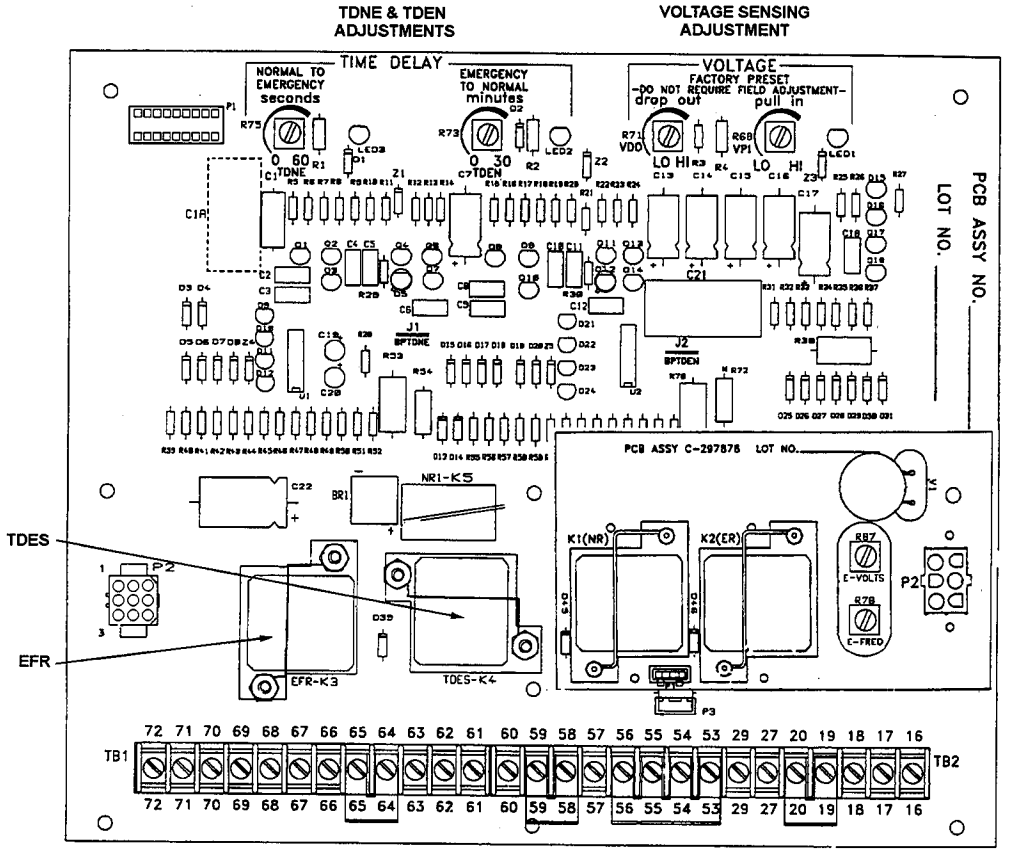
- **TDES** Time Delay on Engine Starting (fixed at 3 seconds). TDES delays initiation of the engine -start circuit in order to ignore momentary power outages of fluctuations. This timer begins timing when the normal source fails. It is intended for use when the emergency source is an engine generator and does not affect the transfer switch's ability to transfer from normal to emergency.

- **TDEN** Time delay on Transfer from Emergency to Normal (adjustable 1 to 30 minutes) TDEN delays retransfer from emergency to normal in order to permit stabilization of the normal power source before retransfer or to allow a minimum generator run time. This timer begins timing when the normal source appears. If the standby source fails while this timer is timing and the normal source is available, the switch will immediately transfer to normal, overriding this time delay.

- **BPTDNE /BPTDEN.** TDNE and TDEN can be eliminated by removing by-pass jumper J1 or J2.

- Test Switch mounted on the enclosure door. The momentary test switch will interrupt power to the normal source relay and simulate a power failure of normal as long as the switch is held in the test position.

CONTROLLER



S340 - - 3 PHASE

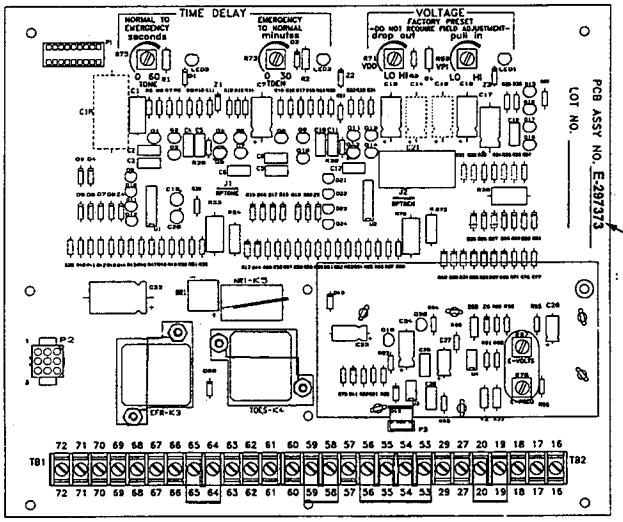
NOTE:
Potentiometers R87 (E-Volts) and R78 (E-Freq.) located under relay board are for factory calibration adjustments only!

S340 CONTROLLER

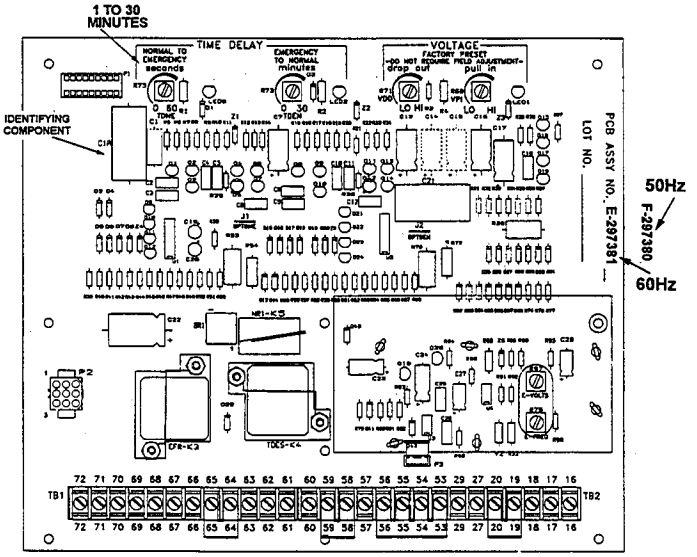
There are eight versions of controller boards available to meet the needs of both single and three phase voltages as well as 50 and 60 Hertz applications.

STANDARD
F- 297372 -1ph. - 50Hz
E- 297373 -1ph - 60Hz
F- 297374 -3ph - 50 Hz
E- 297375 - 3ph - 60Hz

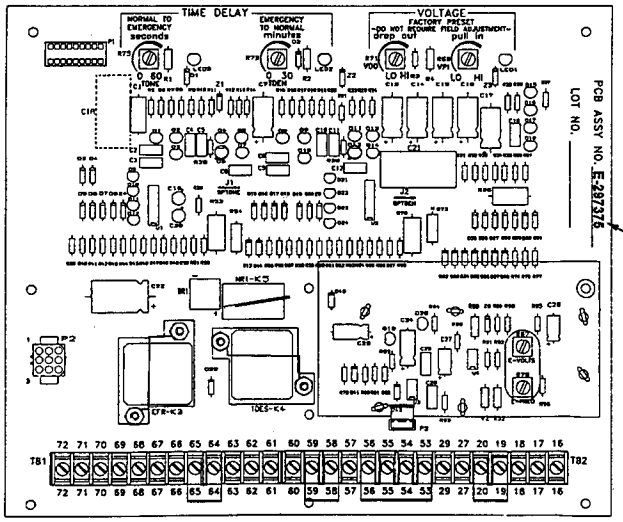
WITH EXTENDED TDNE (1-30 Min.)
F- 297380 -1ph.- 50Hz
E- 297381 -1ph.- 60Hz
E- 297382 -3ph.- 50Hz
E-.297383 -3ph - 60Hz



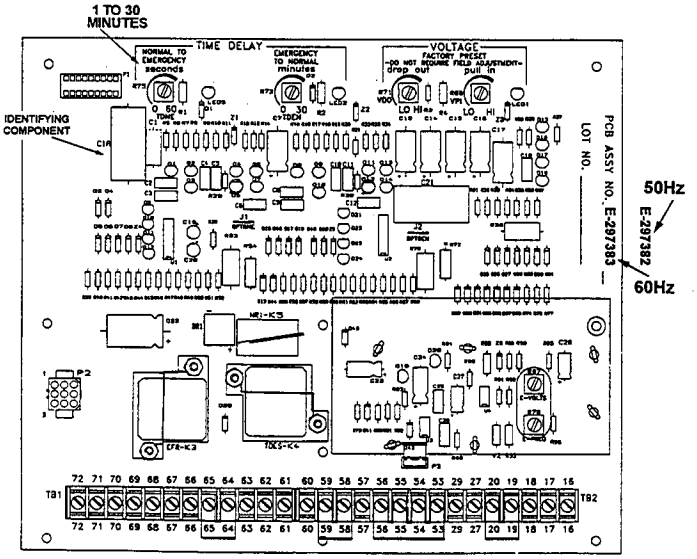
S340 - - 1 PHASE



S340 - - 1 PHASE
TDNE ADJUSTABLE
1 TO 30 MINUTES



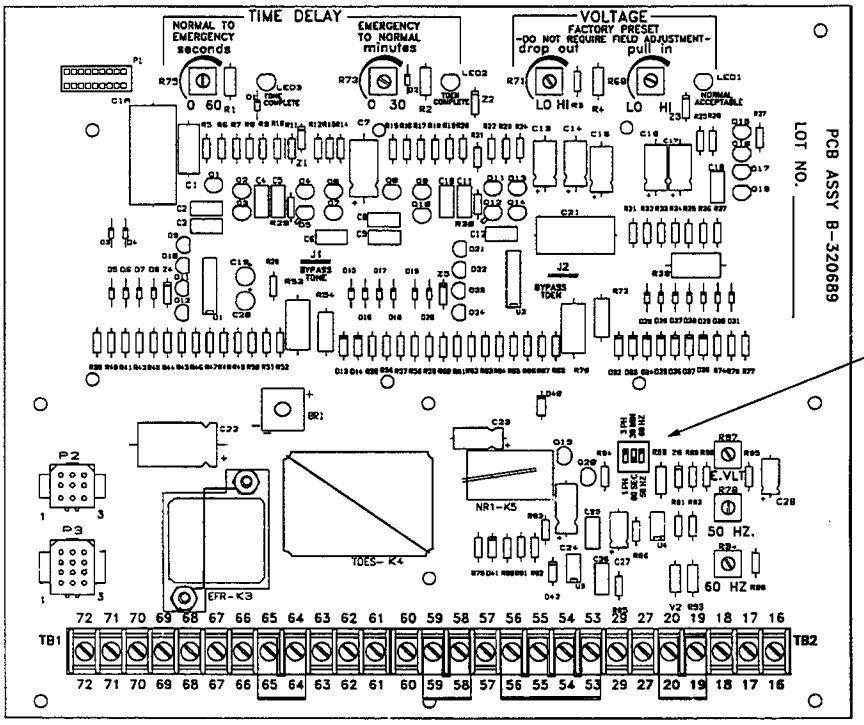
S340 - - 3 PHASE



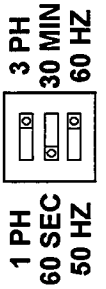
S340 - - 3 PHASE
TDNE ADJUSTABLE
1 TO 30 MINUTES

S340+

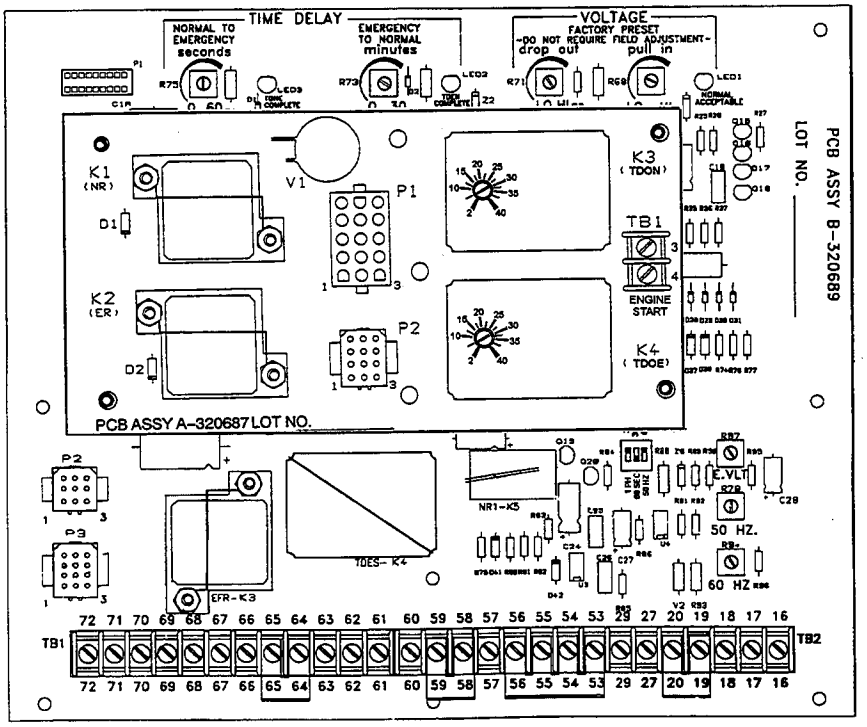
The S340+ controller can be programmed for use on both single and three phase as well as 50 and 60 Hertz systems.



The 3 pole dip selector switch also allows for selection of either 60 sec. or 30 Min. TDEN.



The Interface board may be located on the door panel, in the cabinet or mounted on the main control board as illustrated.



CONTROL RELAYS

Four control relays and one timer relay are standard for both the S340 and S340+ controllers.

Contacts of the NR (Normal) and ER (Emergency) relays control either Normal or Emergency source voltage to the switch transfer mechanism.

The EFR relay coil is energized via a undervoltage/frequency circuit. It will not energize until both the Emergency source voltage and frequency reach the specified level. Contacts of the EFR relay are connected in series with the ER relay coil.

The ER relay is energized by the TDNE circuit. The NR1 relay is energized by the TDEN circuit.

The Time Delay on Engine Start (TDES) is a fixed 3 second 24vdc timer relay which is energized via the NR1 relay contacts. The timing function begins when power is REMOVED. (NR1 contacts open)
At completion of the timing cycle the contacts connected in the engine start circuit (3 - 4) will close. Adjustable timer relays are optional.

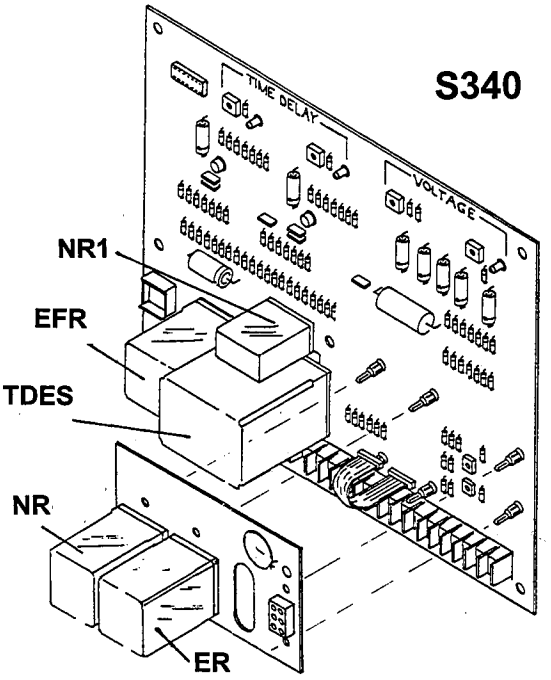
On both the S340 and S340+ controllers the EFR relay, NR1 relay and TDES relay sockets are mounted on the logic board.

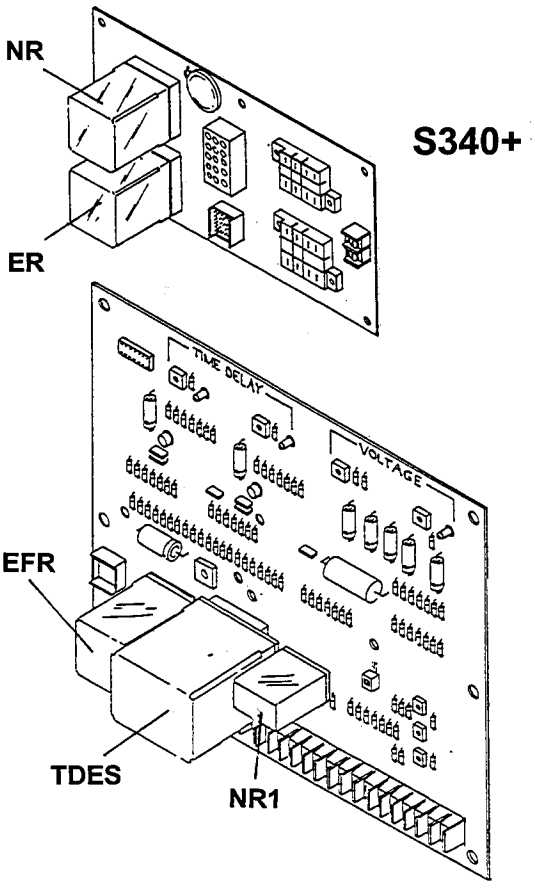
The NR and ER control relays are mounted on separate boards. The contacts of these relays drive the transfer mechanism and require higher current carrying foil and conductor paths.

On S340 controllers the relay board is mounted on standoffs to the main board. Control interfacing is via the P1/P3 ribbon connector and contact interfacing is directed through the P2(B) connector.

On S340+ controllers the NR and ER relays are located on an interface board and interconnected from the P3 connector. The Interface is mounted on the main board or located remotely from the controller board.

NR-ER 12VDC 2 POLE
NR1 12VDC 1 POLE
EFR 12VDC 3 POLE
TDES 24VDC 2 POLE





Typical Sequence of Operation

(Standard switch with no additional options)

Normal Source Failure

Load transfer to the emergency source automatically begins when the voltage-sensing circuit detects reduced voltage or total loss of the normal source. Relay NR1 will de-energize whenever the voltage level falls below the preset dropout point of the voltage sensing circuit.

NR1 relay de-energizes, signaling a failure while the TDES starts its timing cycle. At the same time, the NR relay de-energizes. TDES is a dropout time delay relay designed to override momentary outages. This delay prevents nuisance starting of the generator set. If the normal source voltage returns above the voltage pickup setting before the time delay expires, the NR1 and NR relays will re-energize causing the timing cycle to reset. TDES relay de-energizes after the time delay and signals the generator set to start. The emergency voltage/frequency relay (EFR) monitors the emergency source. The EFR will energize when the emergency source voltage and frequency reach the proper pickup points.

When the emergency source is acceptable, the emergency relay (ER) is energized after a timing cycle (TDNE). The ER relay is controlled by a time delay to prevent immediate load transfer to the emergency source.

When the ER relay energizes, the transfer switch solenoid coil is energized and the switch transfers load to the emergency source.* The transfer switch is now supplying the load from the emergency source and will remain in this position until the normal source is restored.

Normal Source Restoration

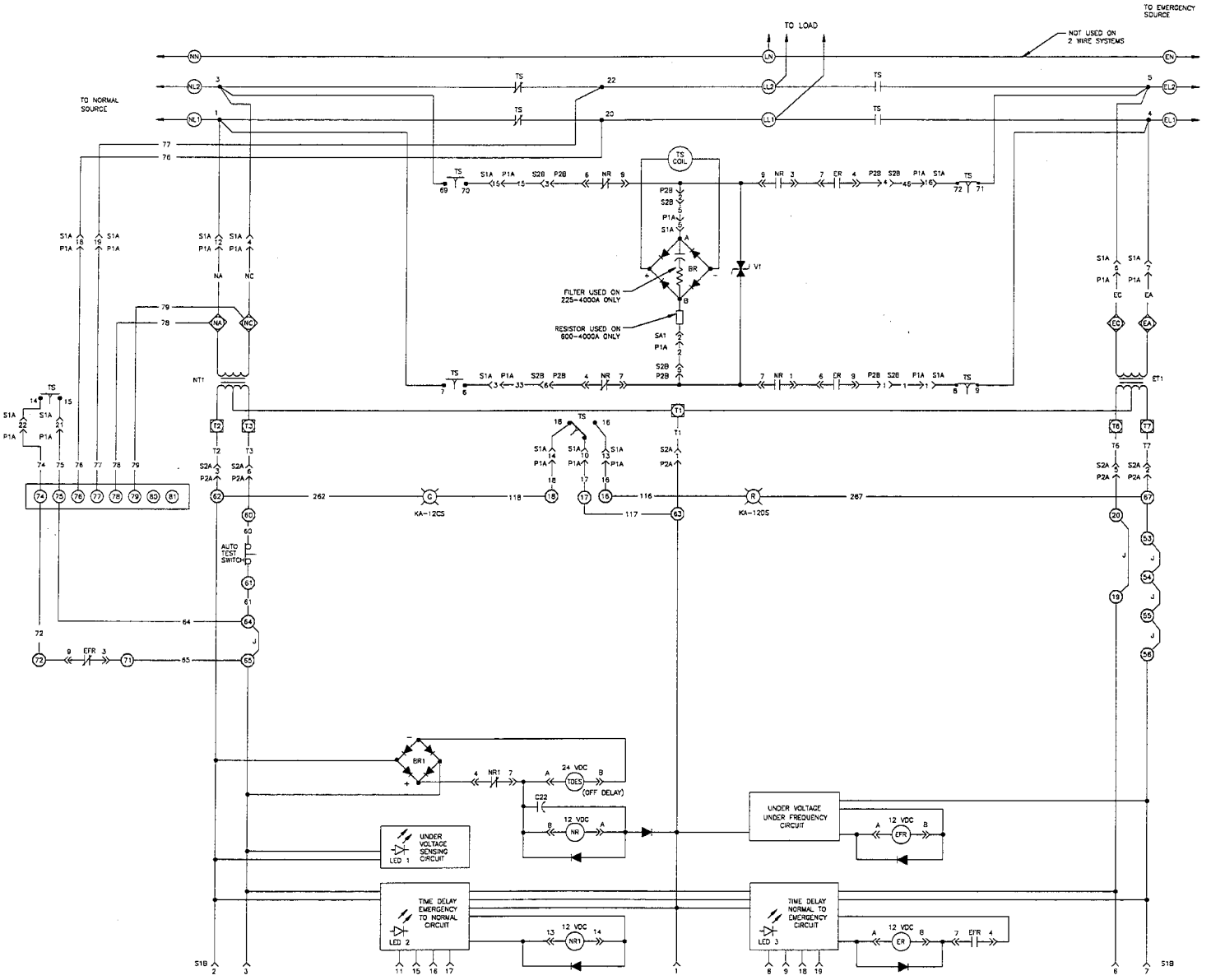
Load transfer to the normal source automatically begins when the voltage-sensing circuit detects restoration of the normal source. The voltage level must rise above the preset pickup point on all phases before the circuit will accept the normal source again. When the normal source is accepted by the voltage-sensing circuit the NR1 relay is energized after a TDEN.

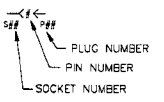
This time delay insures that the normal source has stabilized before vital loads are reconnected.** If the emergency source fails during this timing cycle, the EFR relay drops out and the load is immediately transferred to the normal source, if acceptable. The NR1 relay energizes, which in turn activates the NR relay and the ER relay is dropped out. The transfer switch coil is energized and the switch transfers load back to the normal source. The transfer switch is in the normal position.

S340+ W/Program Transition

*If the Program transition function is utilized an optional time delay relay will stop the transfer in the "off" position for an adjustable time (TDON) when a transfer from Normal to Emergency is initiated.

**On retransfer from Emergency back to Normal, the switch will transfer to the "open" position for an adjustable time (TDOE) prior to transfer to the Normal source.

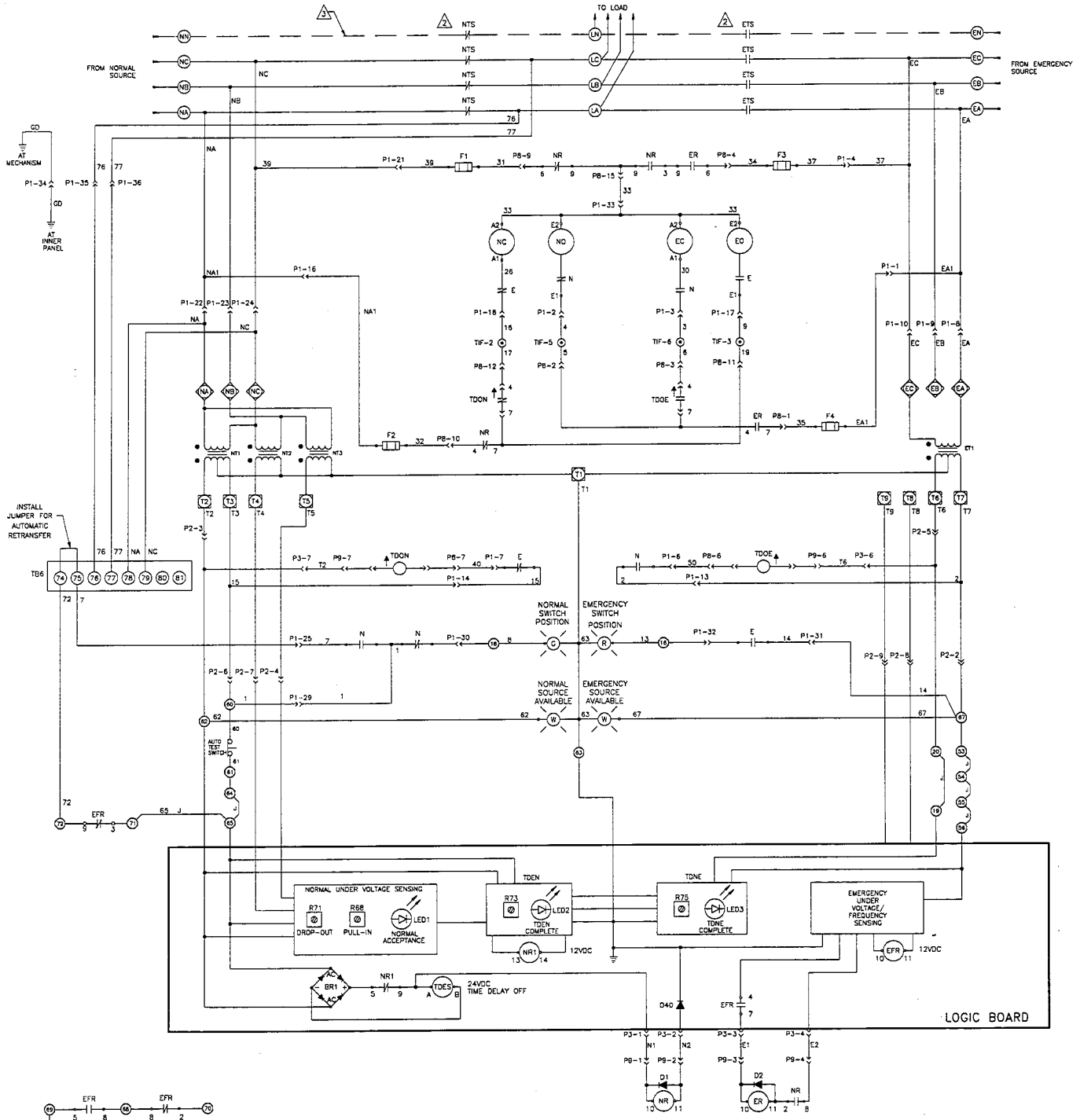


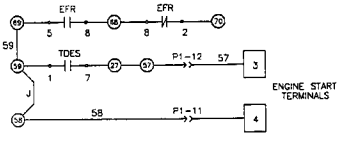


NOTE:
DIAGRAM SHOWN WITH "NORMAL" ENERGIZED AND CONTACTOR IN THE NORMAL POSITION

LEGEND

BR — BRIDGE RECTIFIER
C# — CAPACITOR
EFR — EMERGENCY FREQUENCY RELAY
ER — EMERGENCY RELAY
ET — EMERGENCY TRANSFORMER
D# — DIODE
J — JUMPER
LED# — LIGHT EMITTING DIODE
NR — NORMAL RELAY
NR1 — NORMAL RELAY #1
NT — NORMAL TRANSFORMER
R# — RESISTOR
TDES — TIME DELAY ENGINE START
TS — TRANSFER SWITCH (CONTACTOR)
V# — VARISTOR
○ — COMPONENT CONNECTION
• — INTERNAL COMPONENT CONNECTION
(4) — TERMINAL BLOCK TERMINAL #
(EA) — PRIMARY TRANSFORMER ASSY. TERMINAL BLOCK
(T7) — SECONDARY TRANSFORMER ASSY. TERMINAL BLOCK
(SB) — TERMINAL BLOCK TB1 W/TERMINAL #
— LEAD NUMBER
— CAM OPERATED CONTACT
(R) — INDICATOR LAMP
R - RED
W - WHITE
G - GREEN





NOTES:

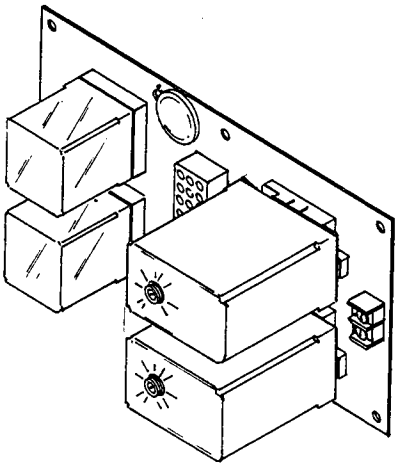
1. ATS SHOWN IN NORMAL POSITION WITH NORMAL POWER PRESENT.
2. NEUTRAL CONTACTS NTS & ETS PRESENT ON 4 POLE UNITS ONLY
3. OPTIONAL NEUTRAL BUS

LEGEND

BR — BRIDGE RECTIFIER
C — CAPACITOR
D — DIODE
E — EMERGENCY CONTACTOR AUX. SWITCH
EC — EMERGENCY CONTACTOR CLOSE COIL
EFR — EMERGENCY FAILURE RELAY
EO — EMERGENCY CONTACTOR OPEN COIL
ER — EMERGENCY RELAY
ET — EMERGENCY SENSING TRANSFORMER
ETS — EMERGENCY CONTACTOR POWER CONTACTS
F — FUSE
J — JUMPER
LED — LIGHT EMITTING DIODE
N — NORMAL CONTACTOR AUX. SWITCH
NC — NORMAL CONTACTOR CLOSE COIL
NO — NORMAL CONTACTOR OPEN COIL
NR — NORMAL RELAY
NR1 — NORMAL RELAY #1
NT — NORMAL SENSING TRANSFORMER
NTS — NORMAL TRANSFER SWITCH POWER CONTACTS
Q — TRANSISTOR
TDEN — TIME DELAY EMERGENCY TO NORMAL CIRCUIT
TDES — TIME DELAY ENGINE START RELAY
TDON — TIME DELAY ON-NORMAL RELAY
TDNE — TIME DELAY NORMAL TO EMERGENCY CIRCUIT
TDOE — TIME DELAY ON-EMERGENCY RELAY

— COMPONENT CONNECTION
— LEAD
— PLUG/SOCKET CONNECTOR
— LOGIC BOARD DIP CONNECTOR
— CONNECTION NODE
— RELAY SOCKET TERMINAL (LOGIC BOARD)
3 — TERMINAL BLOCK ON TRANSFER SWITCH PANEL
4 — TERMINAL BLOCK ON INNER PANEL AND/OR TRANSFER SWITCH POWER TERMINALS
T2 — TERMINAL BLOCK PRIMARY OF TRANSFORMER
T7 — TERMINAL BLOCK SECONDARY OF TRANSFORMER
58 — TERMINAL BLOCK ON LOGIC BOARD
— TERMINAL BLOCK ON INTERFACE PANEL
R — INDICATOR LAMP
W - WHITE
R - RED
G - GREEN

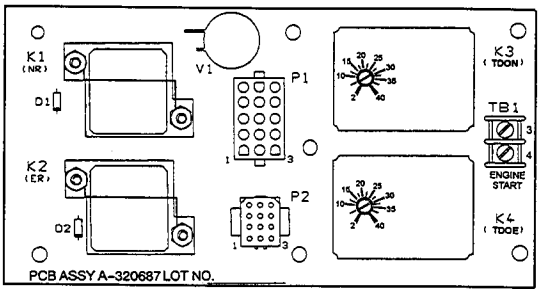
S340+ INTERFACE BOARD
(WITH PROGRAMMED TRANSITION)



An Interface board is used with the S340+ controller to allow easy interfacing of various Transfer and Contactor mechanisms. Control relays NR and ER are installed on the board.

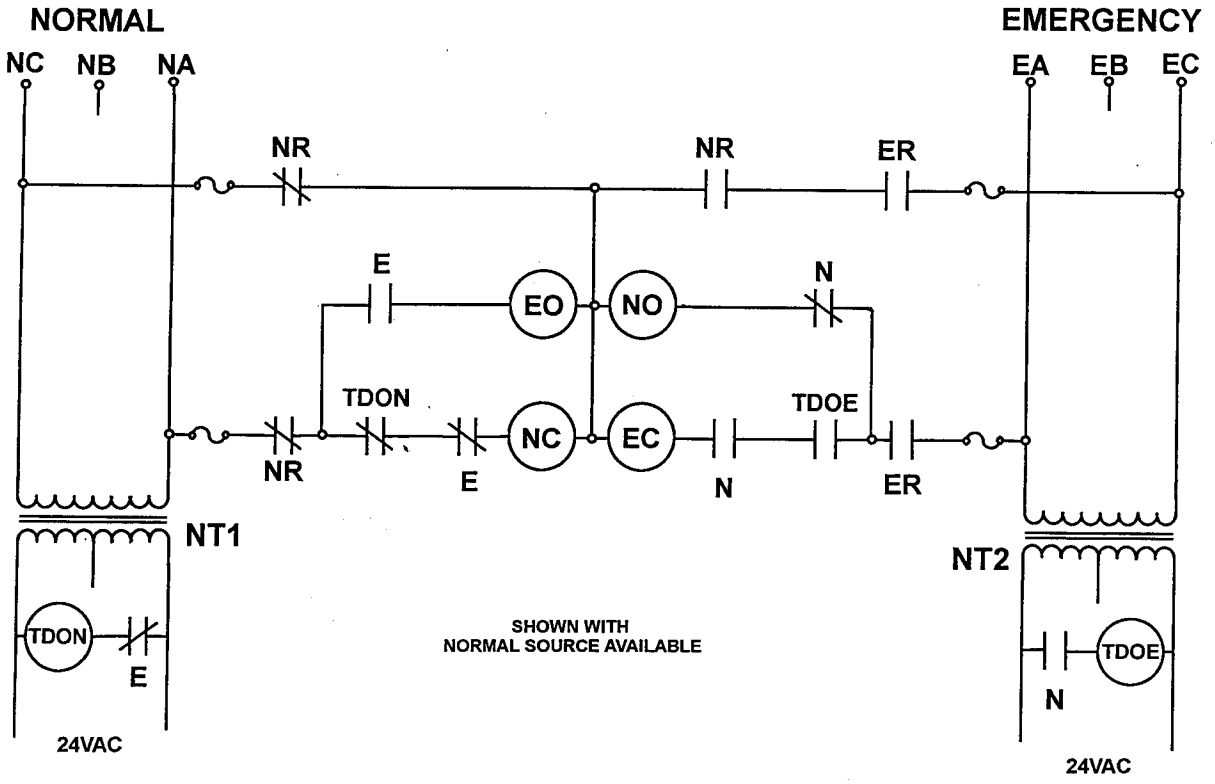
If the Programmed Transition option is provided, timer relays are also installed to allow a predetermined time in the Neutral or "off" position prior to an actual load transfer.

Two 24vac timer modules are used. One to provide a delayed time in the Neutral position prior to transferring to the Emergency source (TDOE) and one to provide a delay time in Neutral prior to retransfer back to the Normal source.(TDON)



This feature requires both a closing and opening coil in the transfer contactor or mechanism.

NC Closing coil, Normal contactor
NO Opening Coil, Normal contactor
EC Closing coil, Emergency contactor
EO Opening coil, Emergency contactor



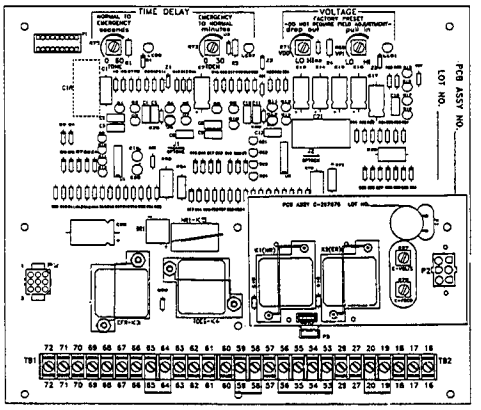
TERMINAL STRIPS

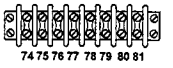
The controller and panel mounted terminal strip provide termination for input power,switches, indicators and contacts.

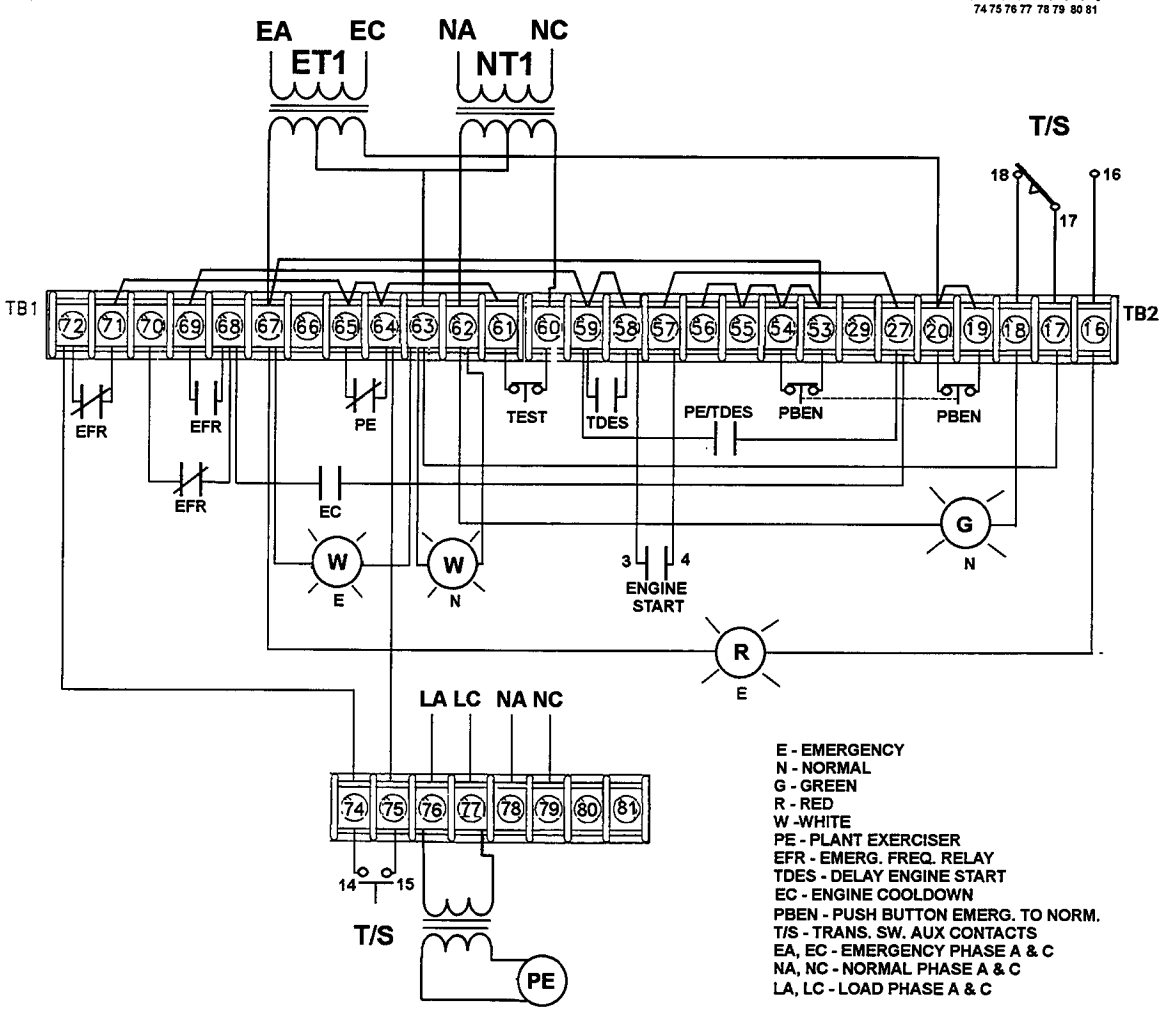
Options may require removal or installation of jumpers in addition to the device.

The diagram illustrated shows a combination of optional connections and is only a sampling of possibe jumper locations.

S340 - - 3 PHASE

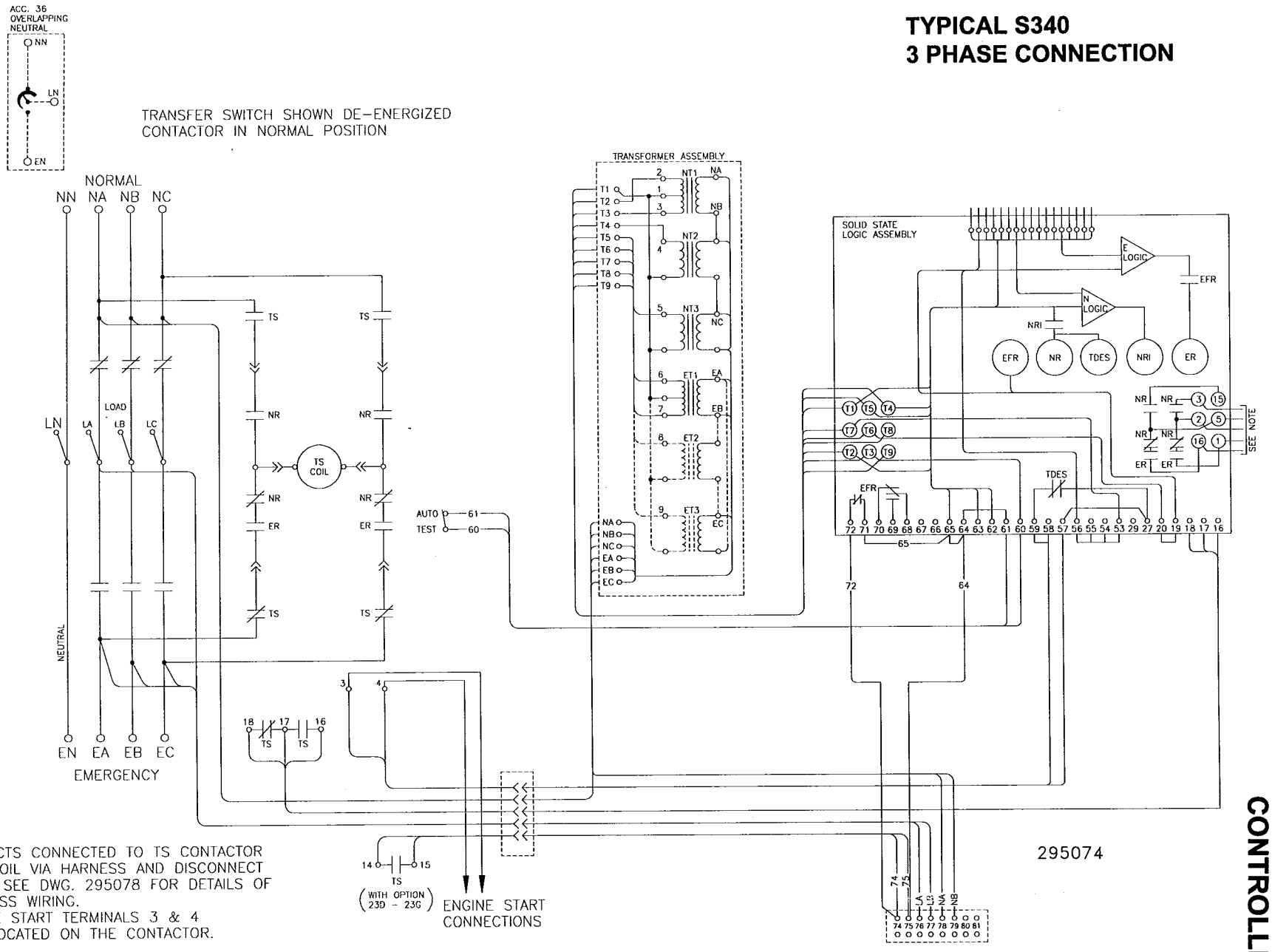






E - EMERGENCY
N - NORMAL
G - GREEN
R - RED
W -WHITE
PE - PLANT EXERCISER
EFR - EMERG. FREQ. RELAY
TDES - DELAY ENGINE START
EC - ENGINE COOLDOWN
PBEN - PUSH BUTTON EMERG. TO NORM.
T/S - TRANS. SW. AUX CONTACTS
EA, EC - EMERGENCY PHASE A & C
NA, NC - NORMAL PHASE A & C
LA, LC - LOAD PHASE A & C

TYPICAL S340
3 PHASE CONNECTION



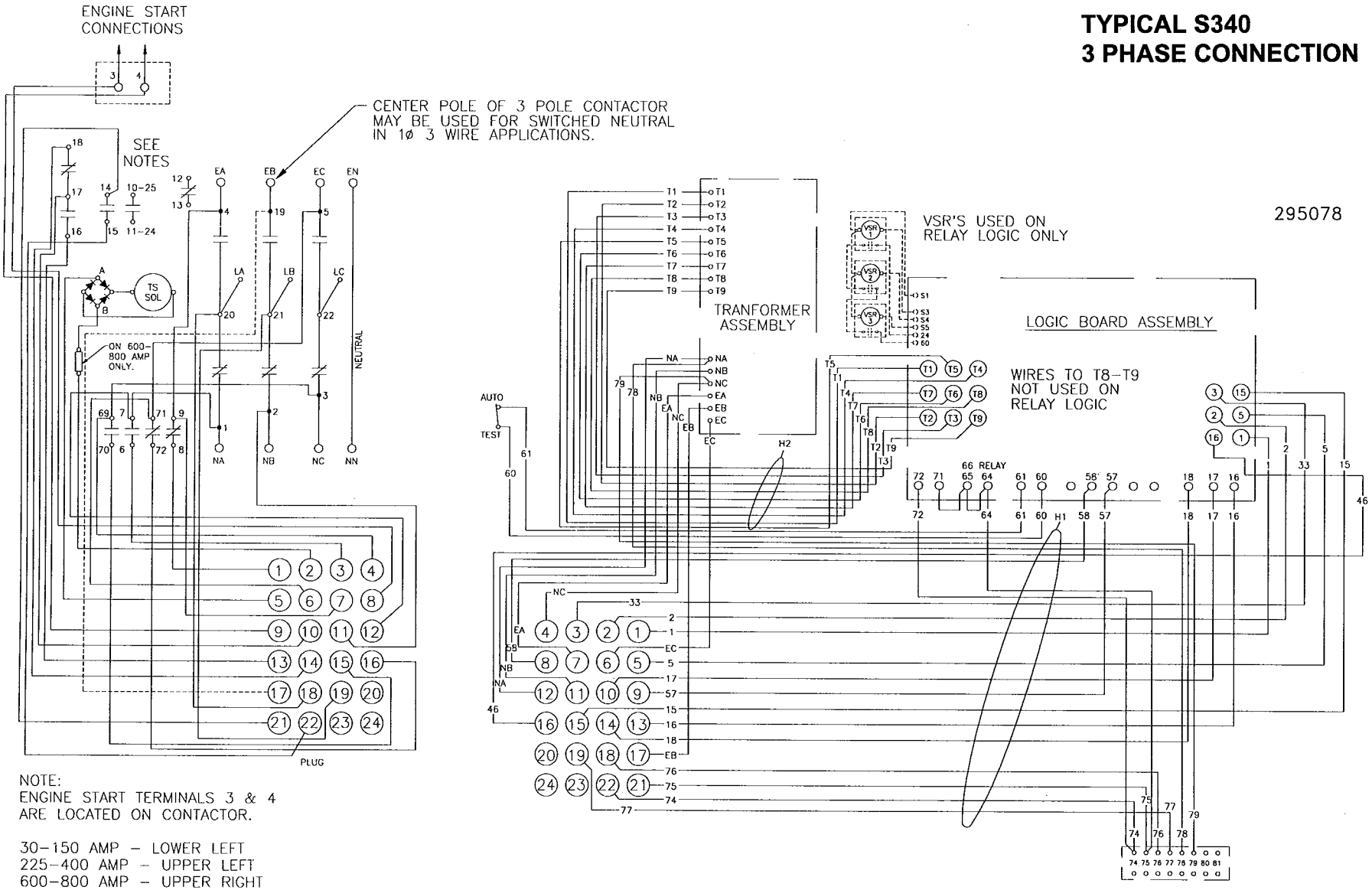
NOTE:
1. CONTACTS CONNECTED TO TS CONTACTOR AND COIL VIA HARNESS AND DISCONNECT PLUG. SEE DWG. 295078 FOR DETAILS OF HARNESS WIRING.
2. ENGINE START TERMINALS 3 & 4 ARE LOCATED ON THE CONTACTOR.

30-150 AMP - LOWER LEFT
225-400 AMP - UPPER LEFT
600-800 AMP - UPPER RIGHT
1000-1200 AMP - UPPER LEFT
1600-4000 AMP - LOWER LEFT

AUTOMATIC TRANSFER SWITCH
3ø-3 OR 4 WIRE
30-4000 AMP

CONTROLLER

TYPICAL S340
3 PHASE CONNECTION



NOTE:
ENGINE START TERMINALS 3 & 4
ARE LOCATED ON CONTACTOR.

30-150 AMP - LOWER LEFT
225-400 AMP - UPPER LEFT
600-800 AMP - UPPER RIGHT
1000-1200 AMP - UPPER LEFT
1600-4000 AMP - LOWER LEFT

24-25 AUX. SWITCH ON
30-100 AMP - 240 VOLT

10-11 & 12-13 AUX. SWITCH ON
30-4000 AMP - 600 VOLT

WIRING HARNESS FOR
AUTOMATIC TRANSFER SWITCH
3Ø- SOLID STATE OR RELAY
LOGIC BOARD.

ACCESSORIES S340
(CARD CAGE)

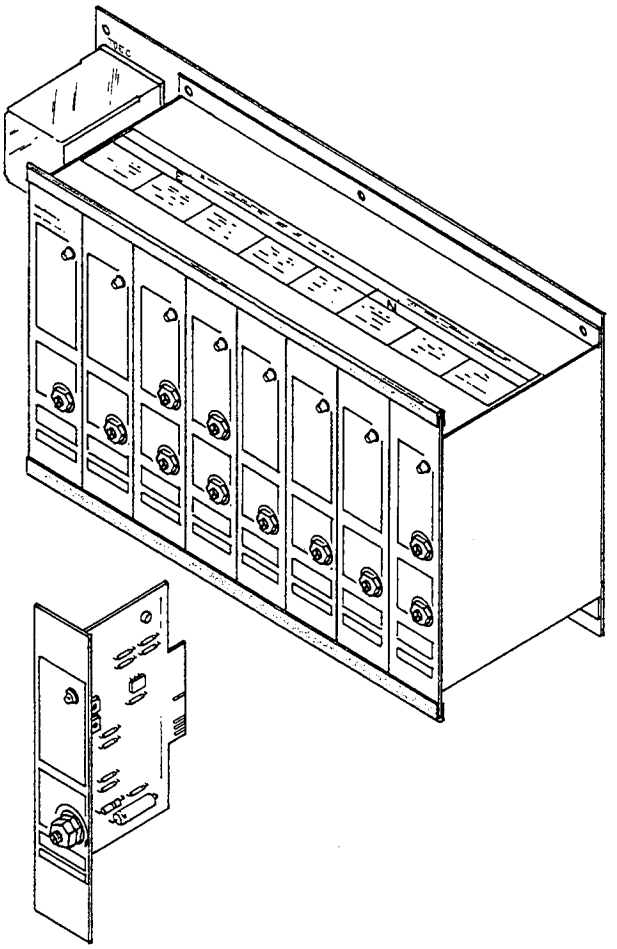
Circuit boards for additional monitoring of the Normal and Emergency source voltage and frequency and a delayed engine shut-down can be installed in an optional 8 slot card cage. Blank covers are installed over unused slots.

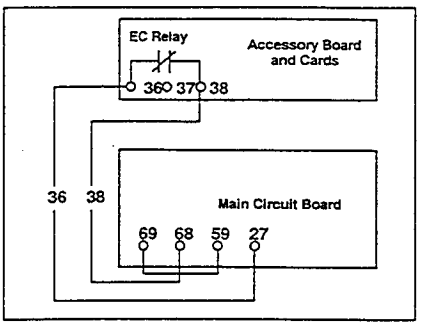
The first 5 slots are allocated for the Emergency source. **Under Frequency, Over-Frequency, Over-voltage, Under-Voltage** and **Time Delay Engine Cool-down (TDEC).**

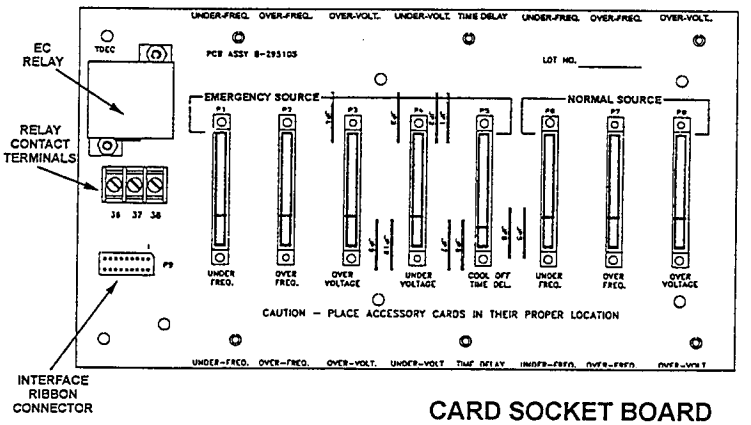
A fixed **TDEC** of 5 min. or an adjustable delay from 1-30 minutes can be selected. A relay **(EC)** is included with this option which will energize at the end of the timed period. The LED on the board will light when the time has elapsed.

Adjustable Under-Frequency (45 - 60 Hz.), Over Frequency (55 - 65Hz.) and Over-Volltage (100% - 115%) are also offered for the Normal source.

Voltage and Frequency cards performing the same function are interchangeable between the Normal and Emergency slots. Both single and three phase voltage cards are available.
An LED will indicate when the condition is within its setting.







CARD SOCKET BOARD

NOTES

TRANSFER SWITCH BASICS

TRANSFER SWITCH (TS)

Transfer switches are used to transfer electrical loads to alternate power sources.

The most common application is to provide switching of a facilities electrical load from its primary source to a secondary supply should the primary fail.

The prime or normal source in most cases is an electrical utility but could be a generator set. The secondary or emergency source is usually a diesel or gas powered generator set but could also be another utility.

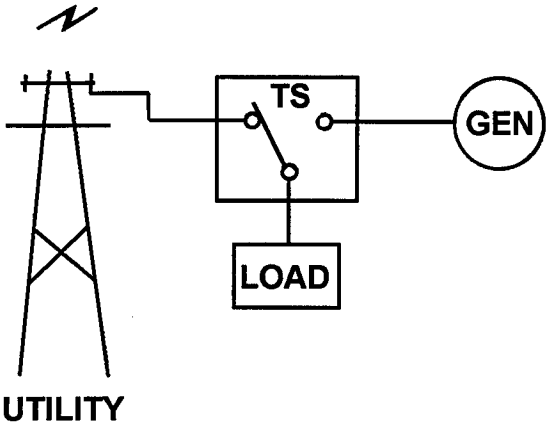
The Transfer switch is a required component of an emergency or standby electrical power system. It not only serves to transfer the load between electrical supplies but also to prevent the sources from being connected together resulting in destruction of the system. It is not used to parallel two or more sources to a common bus.

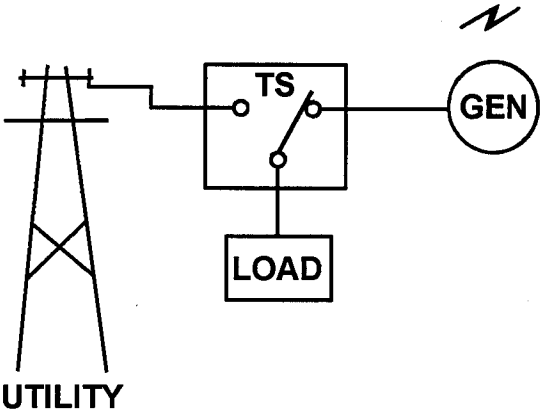
Transfer switches are used wherever faulty or loss of electrical power could cause damage to equipment, loss of revenue, endanger people or result in the loss of life.

Normal or utility power could be lost due to equipment failure or natural disasters resulting in a total blackout.

Brown outs can be even more costly and damaging to equipment especially expensive voltage sensitive electronic devices. Circuit breakers intended to protect against over current faults will not offer disconnect protection from low voltage conditions.

Transfer switches can be as simple as a manually operated switch or sophisticated as Micro-computer controlled devices which perform all functions automatically and allow the switch to be monitored or controlled remotely via a modem and computer.



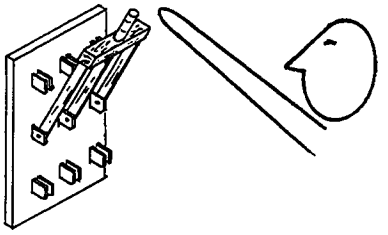


TRANSFER SWITCH BASICS

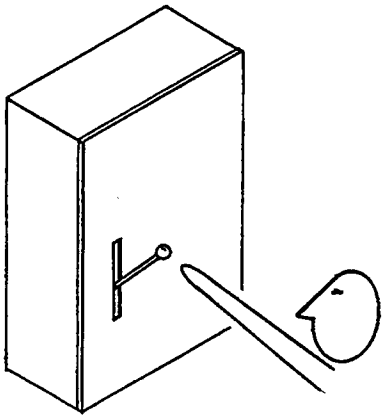
TYPES OF TRANSFER SWITCHES

MANUAL

In applications of a non-critical or non-emergency nature a manual operated transfer switch may be adequate; homes, farms etc.



The most basic type of manual transfer switch is a double throw knife switch. These however offer no safety protection and an operator must be present to perform the transfer as well as start the generator set. The operator must also insure there is no load connected when he opens or closes the switch. This is not a recommended system however the double throw concept is used.

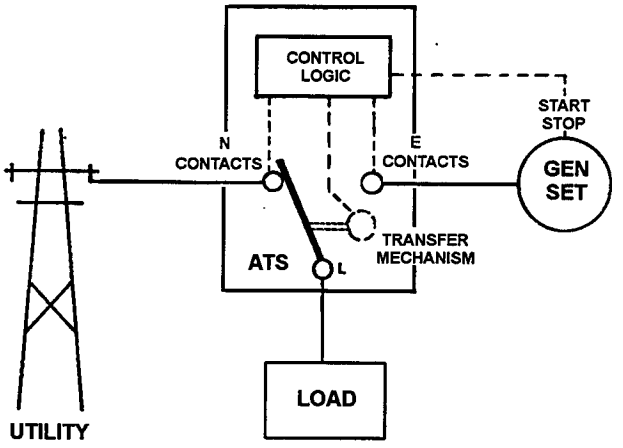


If a manually operated switch is desired quick/break, quick/make operating mechanisms are used with an operating handle external from the switch cabinet. These mechanisms are capable of transfer speeds similar to electrically operated devices.

AUTOMATIC (ATS)

The majority of applications requiring a transfer switch are facilities with critical electrical loads which effect the safety of personnel and equipment. If the normal power supply fails an alternate source must be automatically supplied within seconds. This is the function of the ATS.

A sensing circuit in the ATS constantly monitors the condition of the normal power.
If the emergency source is a generator, a signal for an engine start will be given when the normal voltage or frequency is not at a predetermined level or fails completely.



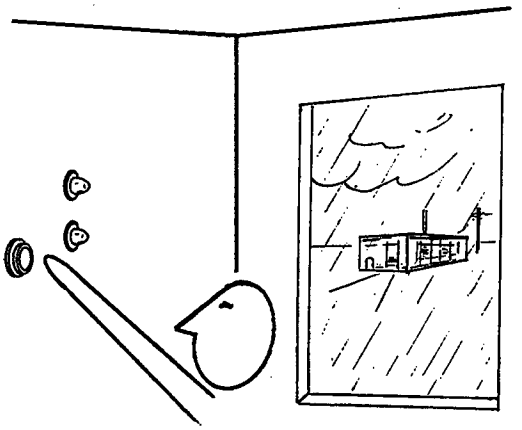
When the generator voltage and frequency are acceptable to the monitoring circuit the switch will transfer the load to the generator.

The switch will always seek the primary source and on return of acceptable power will retransfer the load back to the normal position and initiate an engine shut down.

TRANSFER SWITCH BASICS

NON-AUTOMATIC

The transfer mechanism of the non-automatic switch is the same as the quick-break/make mechanism of the automatic operated switch. It however requires the presence of an operator to initiate the transfer with a push button or toggle switch.



The switch can be mounted at the load site and transfer controlled from a remote location and monitored with source indicator lights.

An option available for the Non-Automatic switch is an automatic delayed generator engine start upon failure of the Normal source. Switch transfer to the emergency source however is push button controlled.

The delayed engine start option will also provide an automatic engine shutdown on retransfer back to the Normal source.

There may be applications where a combination of an Automatic and non-automatic switch is desired. The transfer from normal to emergency is automatic but retransfer back to normal is manual.

If an area has frequent power problems or weather related outages a retransfer back to the utility may be controlled manually after the weather has stabilized rather than possible repeated transfers throughout the storm.

TRANSFER SWITCH BASICS

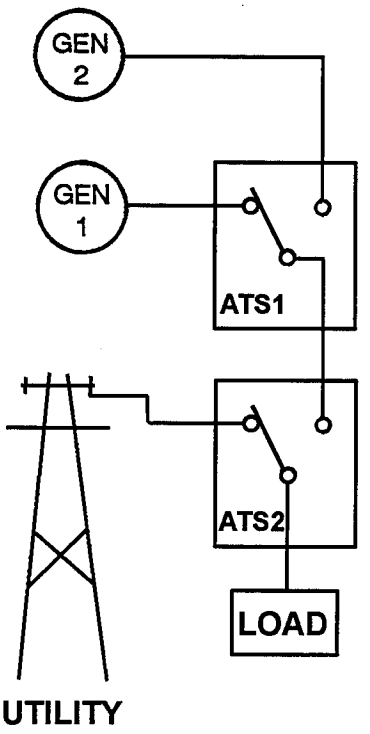
ATS SYSTEMS

The ATS is the most commonly used transfer switch and is specified for hospitals, health care centers, commercial and industrial buildings or any facility that can not afford to be without an unattended, automatic electrical back-up system.

Facilities having critical loads may consider a redundant system.

3 SOURCE SYSTEM

This scheme requires two emergency sources and two transfer switches. If the emergency sources are generators both will be signalled to start on a power failure. The first generator to provide acceptable voltage and frequency will initiate transfer of ATS1 to its output. When ATS2 senses the available power it will transfer the load to the emergency source. The remaining generator will be shutdown and remain in standby readiness should the first generator fail.



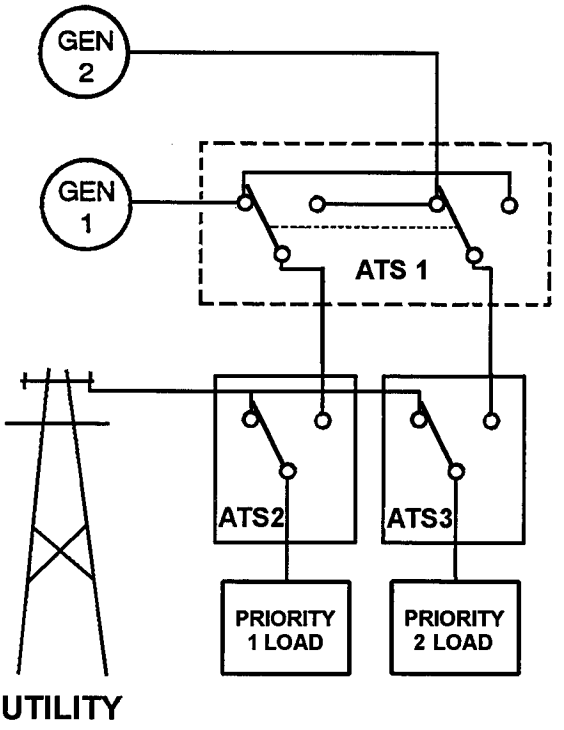
3 SOURCE PRIORITY

A more complex version of this scheme is a Three Source Priority Load system which requires two interlocked transfer switches for generator selection and two for load selection. This allows the second generator to be connected to another less critical load and remain a redundant backup for the more critical or priority load.

Both generators will receive a start signal on a normal source failure. The first generator to reach acceptable power will connect the ATS 1 contacts feeding the Priority 1 load ATS to its output. The second generator will supply the emergency contacts of ATS 3, and the priority 2 less critical load.

If the generator powering the critical load fails the ATS 1 will transfer the critical load to the secondary generator and shed the less critical load.

When normal power returns ATS2 and ATS3 will retransfer to their normal positions and the generators will shut down.



ATS COMPONENTS

As we can see from the brief sampling of ATS applications, these switches must be very reliable and operate under adverse conditions while unattended.

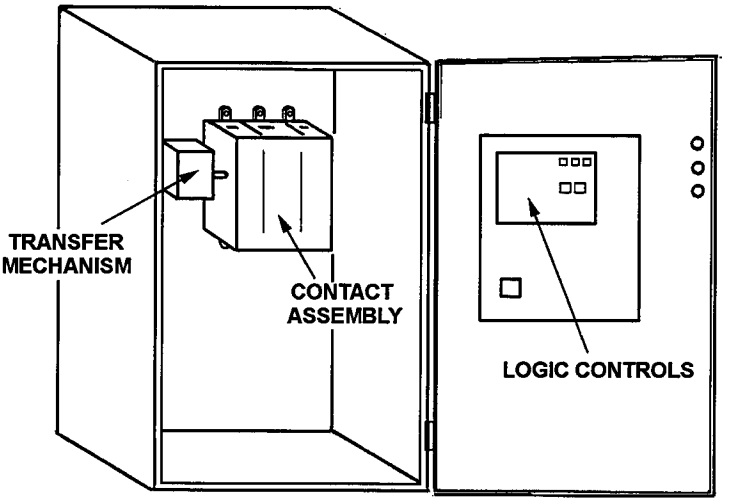
There are codes which govern emergency power systems as well as stringent tests and standards which switch manufactures are expected to comply to.

Several methods of design are used in the construction of an ATS to meet these requirements, all have three major components and are contained in an enclosure:

1. CONTACT ASSEMBLY
    - A. Contactors.
    - B. Molded case breakers.
    - C. Circuit Breakers.

2. TRANSFER MECHANISM
    - A. Solenoid Operators.
    - B. Motor Drives.

3. LOGIC CONTROLS
    - A. Relay
    - B. Solid State
    - C. Micro Computer



A Switch may be assembled with any combination of the above.

The Contact Assembly which is sized to carry the current rating of the switch may be circuit breakers or contactors.

The Transfer Mechanism which opens and closes the power contacts could be motor driven or Solenoid operated.

The Logic Control which monitors the power sources, controls the transfer mechanism and generator starting and stopping could be relay, solid state or both.

Any combination or variations of the above can be found in use in the transfer switch market.

The application will determine which system is best suited or more economical.

RATINGS

CONTINUOUS

Transfer switches are rated at the amperage load they are capable of carrying on a continuous basis. This ***continuous*** rating is equal to the nominal switch nameplate rating.

Most transfer switches however are designed and tested to meet more severe ratings required by UL;

WITHSTAND

They must also ***withstand*** short time abnormal conditions such as a line to line or line to neutral short circuit until some upstream circuit breaker or fuse opens to clear the fault.

A UL required withstand time is a minimum of 3 cycles (.05 sec.). If the transfer switch does not have a built-in overcurrent protection device the contacts must not separate within this period of time.

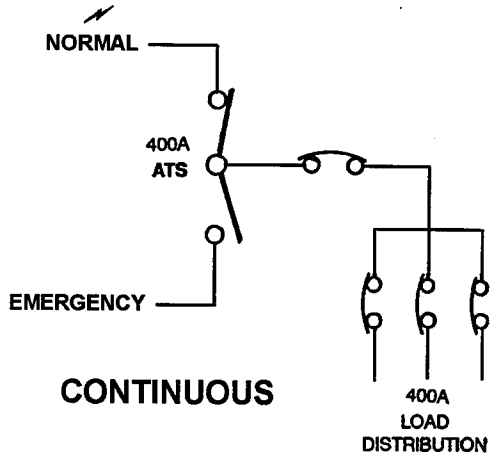
CLOSING

If the transfer switch is called upon to start the generator and transfer or close-in the emergency source to a short fault, it must perform equal to the withstand rating. This is the ***closing*** rating.

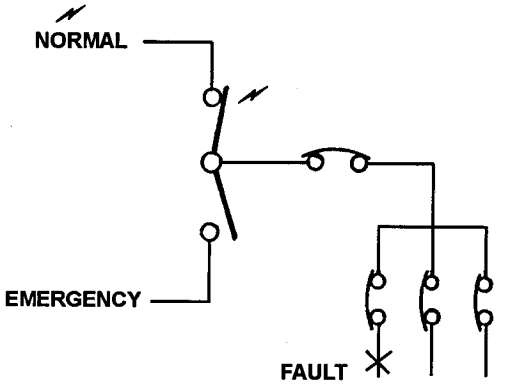
INTERRUPTING

Transfer switches with integral circuit protection must be capable of ***interrupting*** currents equal to their withstand and closing rating.

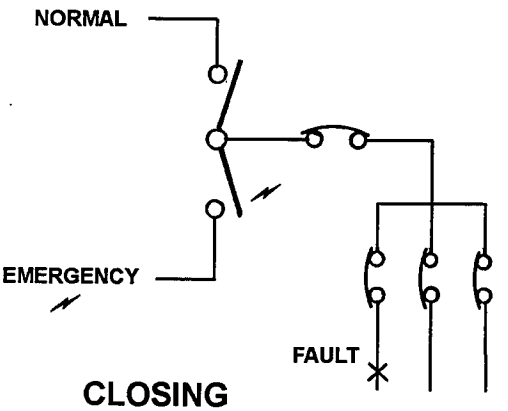
UL requires switches without integral circuit protection to be capable of operating a specific number of times with an overload of 6 times rated current at .4 to .5 power factor. The test cycle is determined by the switch ampere size.



CONTINUOUS



WITHSTAND



CLOSING

MOTOR TRANSFER

When transferring an inductive load such as motors between two live sources the voltage at the motor does not instantly drop to zero when the contacts open but sustains a residual or regenerative voltage for a short period of time. This voltage may be out of phase with the incoming source resulting in a high inrush current similar to paralleling out of phase.

The protective circuit breaker may trip and require manual resetting or even worse, cause damage to the motor.

The abnormal inrush current depends on the motor size and load inertia and is more critical to 3 phase motors of 50 HP and above. If the circuit contains various non rotating, non capacitive loads along with the motor the residual voltage may be quickly absorbed and the condition not as severe.

There are several methods used to eliminate this problem. Not all however lend themselves to all applications or the various transfer switch mechanisms.

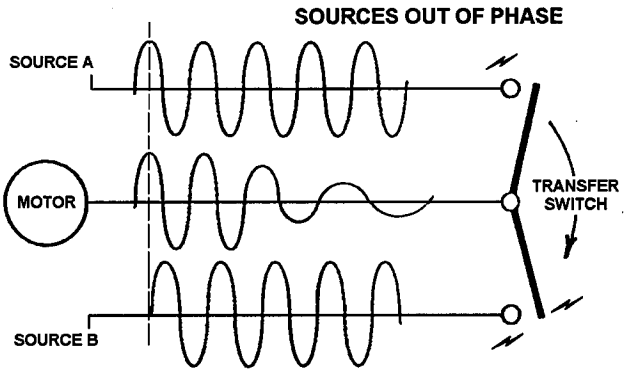
INPHASE TRANSFER

This method requires a very fast transfer switch and uses a monitor to sample the phase angles of the two electrical sources. A transfer is only allowed when the two voltages approach zero phase angle. The **Inphase Monitor** is a very effective device when used with a standard double throw transfer switch.

A key advantage is that it allows the motor to continue to run with minimal disturbance to the electrical system.

LOAD SHED

This system requires momentarily disconnecting the motor for a specific time prior to an actual switch transfer. Delay depends on the motor load, approximately 3 seconds is usually sufficient to insure decay of the residual voltage. After transfer the motor or motors can be sequentially restarted minimizing the generator size required. Power disturbance to the remaining load is minimal.



PROGRAM TRANSITION

The Program Transition (Center Off/ Time Delay Neutral) method requires a switch capable of being in a neutral position. The load is not connected to any power source for a preselected period of time.

The transfer to neutral or "off" occurs when a transfer is initiated. The amount of time the switch remains in the neutral position is a programmed event which allows for the decay of the motor regenerative voltage. A delay of 2 to 40 seconds is typical. Upon completion of the delay, transfer to the alternate source will occur.

The disadvantage of this method is that any other loads connected to the switch will also be disconnected during the "off" cycle.

CLOSED TRANSITION

If it is essential that an emergency electrical power system be periodically tested under load, without an interruption in power to the load, the closed transition or overlap transfer method can be considered.

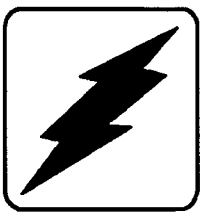
This system becomes more complex in that the power sources are momentarily paralleled at time of transfer eliminating the "off" time or open transition period. The mechanism design must allow the switch to be capable of being in the closed position to both sources at the same time.

Even though synchronized connection to the utility is momentary, approval from the utility is recommended prior to its use.

KOHLER® POWER SYSTEMS

Training Manual

Transfer Switch Controller
S340
S340+



TP-6003