SAMI STAR

User Manual

SAMI STAR Adjustable Frequency AC Drives 30 to 900 HP

SAMI STAR-US-04A
EFFECTIVE 12/1/94
SUPERCEDES NONE

ABB Drives

ABB

SAMI STAR Adjustable Frequency AC Drives 30 to 900 HP (AC-Scalar)

User Manual

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Table of Contents

Chapter 3 – Installation

Chapter 4 – Firmware Description

Chapter 6 – Troubleshooting

Appendix

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Chapter 1 – Introduction

How To Use This Manual

This chapter describes the purpose and contents of this manual, describes the intended audience, explains conventions used in this manual, and lists related publications.

Chapter 1 – Introduction, the chapter you are reading now, introduces you to the *SAMI STAR Adjustable Frequency AC Drives 75 to 900 HP Installation & Start-up Manual* and conventions used throughout the manual.

Chapter 2 – Hardware Overview of the SAMI STAR, describes drive module operation, components and provides a brief circuit board overview.

Chapter 3 – Installation Instructions, describes planning for drive installation, new drive inspection, and drive mounting. This chapter also includes requirements and connections for input and output wiring and external control wiring.

Chapter 4 – Firmware Description, describes operation of the basic drive Scalar Program. The various function blocks are described in detail along with the parameters that accompany them. Also covered are default parameters and set start-up parameters.

Chapter 5 – Start–up Procedure, describes safety, installation inspection, how to check default parameters and set start-up parameters, and how to test the drive with the motor disconnected and connected.

Chapter 6 – Trouble shooting, describes troubleshooting procedures through fault messages, resetting faults, accessing stored information in the fault history, and tracing faults to their origins.

Appendix A – SAMI STAR Parameter Table lists the firmware parameters associated with the drive. The list includes parameter default values and range of adjustment

Appendix B – SAMI STAR Extended Parameter List includes additional parameter addresses and their names.

Appendix C – SAMI STAR Technical Data, lists input and output voltages, amperage, and other useful data for the drive.

Glossary lists and defines terms common to all SAMI STAR drives.

Index helps locate the page number of topics contained in this manual.

Intended Audience

This manual is intended for use by personnel familiar with the functions of solid-state drive equipment. Included in this manual are reference materials which will allow the reader to operate, maintain, troubleshoot and perform basic adjustments to the SAMI STAR AC drive.

The drive hardware can be packaged in several configurations. The inverter hardware of the drive, which controls the AC motor, remains functionally the same in all configurations. This manual provides detailed information for installation and start-up of the drive, including basic troubleshooting information. Also included are brief descriptions for operation and general hardware configurations.

The drive Inverter Unit can be operated as either a Scalar controlled drive (opened loop), or as a Vector controlled drive (closed loop) with minor software and hardware differences. This User Manual is designed to be applicable to the general hardware for the Scalar drive version. For a detailed description of the software associated with either type of control, refer to ABB Industrial Systems Inc.

In addition to the basic difference in control scheme, hardware configuration determines the type of information that is supplied. This User Manual details hardware associated with a single motor drive inverter operating on Scalar Control Software.

Should Technical questions arise which can not be answered from this manual, please consult ABB Industrial Systems Inc.

Description of Equipment

The SAMI STAR AC drive is a fully digital drive which converts 3 phase, 60 Hz input power to an adjustable AC frequency and voltage source for controlling the speed and torque of AC squirrel cage motors. The drive is available in ratings from 30 kVA to 730 kVA at 460V AC input (140 kVA to 870 kVA at 575V AC input). The output voltage varies proportionally with the output frequency to maintain a constant excitation value from 0 Hz to 60 Hz. Additionally, the drive can provide constant horsepower operation or constant excitation to 200 Hz, if required.

The modular design allows maximum flexibility. Regenerative drives using a Thyristor Braking Unit (TBU) provide the ability of sending power back to the AC line. The power factor with the standard non-regenerative diode bridge rectifier is 0.95 lagging or better. Drive efficiency is approximately 98% at full load and full speed.

The standard drive includes power conversion components, power and control logic devices and regulator circuitry. A microprocessor is used to control the drive regulators and power semiconductors which generate a Pulse Width Modulated (PWM) output waveform. Fault detection circuits utilizing numerical displays are provided for fault indication. All components are mounted in a NEMA Type 1 enclosure sized to dissipate the heat generated by the control within the limits of the specified environmental and service conditions.

Two types of inverter bridge power devices are utilized in SAMI STAR drives; Giant Transistors (GTR) are used in all inverters rated 140 kVA and below, while Gate Turn Off Thyristors (GTO) are used in all higher rated drives. The main control cards used in the control function remain the same regardless of inverter power bridge rating. The power supply and pulse amplifier cards however, are specific to the GTO or GTR drive due to the power requirements of the bridge devices.

Hardware Configurations

The SAMI STAR AC drive consists of an assembly of various modules which are the common building blocks used in all of the various system applications. In this particular configuration, any module in excess of 150 lbs. is constructed on roll-out wheels for ease of maintenance.

The basic hardware modules used with an individual drive are illustrated in Figure 1-1. In smaller rated drives, some of the modules are grouped together to form a larger module. One example of this is the Line Supply Unit (LSU) which is comprised of the Contactor Unit (CTU), Line Converter Unit (LCU) and Capacitor Bank Unit (CBU).

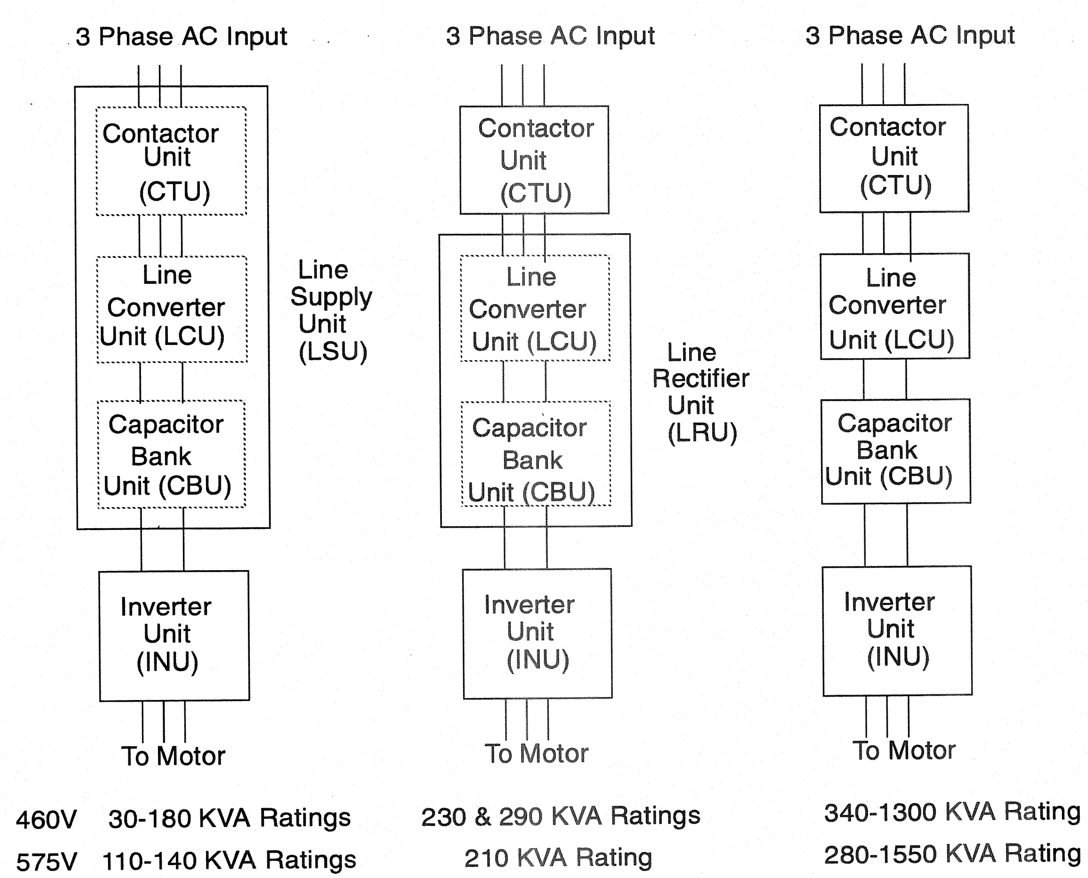


Figure 1-1 Drive Modules For Single Drive Applications

A summary of the modular units and their abbreviations is provided in Table 1-1.

Table 1-1 Unit Abbreviations

Module	Abbreviation
Contactor Unit	CTU
Line Converting Unit	LCU
Capacitor Bank Unit	CBU
Line Rectifier Unit	LRU
Line Supply Unit	LSU
Inverter Unit	INU

Safety

The SAMI STAR drive provides adequate circuit protection not only to motor circuits connected to it, but also to the drive itself. These circuit protection parameters must not be altered. Failure to comply may compromise the safety of the system and invalidate any warranties.

WARNING: Only qualified personnel familiar with the SAMISTAR, AC drive and its associated machinery should plan or implement the installation, start up and subsequent maintenance of the drive. Failure to comply may result in personal injury and/or equipment damage.

Recognized safety regulations must be observed in the installation, start-up and maintenance procedures. Refer to Electrical Safety Requirements for Employee Workplaces, for installation safety requirements and general requirements for electrical installations.

Operation - The operation of the drive should be the responsibility of personnel who are familiar with its basic functions. The operator should be informed of the significance of the Numeric Displays on the Control Panel. In case of a panel alarm indication, possibly followed by tripping, the operator must be able to decide whether the drive should be removed from operation or whether it should be restarted after resetting the alarm.

Maintenance Work - All drive maintenance must be performed by an experienced electrician, familiar with the drive as well as with solid state electronics.

To guard against possible injury that can result from accidental contact with live parts or improper procedures, the following points must be observed before any work is begun on the drive:

A. If the drive is equipped with bypass equipment, supply voltage may also be fed back to the drive cabinet through the output terminals.

WARNING: If the bypass circuitry is in the same bay as the drive, perform maintenance only when **BOTH THE DRIVE AND BYPASS ARE DE-ENERGIZED.**

If the bypass equipment is in a separate bay:

1. With all power **OFF** disconnect power cables between the drive and its output contactor. This isolation guards against voltage feedback by potentially welded contacts.

2. Take careful note of all power cables and control wiring which may be live when bypass mode is in operation.

3. Proceed with Extreme Caution.

CAUTION: To avoid damage to equipment, motor rotation should be checked while in the Bypass Mode (if supplied). If adjustment is necessary, interchange any two of the input cables to the system. **DO NOT** make correction by adjusting leads at the motor or output of the inverter.

B. Since all semiconductors exhibit leakage current, the circuits of the drive and motor should be regarded as live. DO NOT touch any components until the drive has been isolated from the supply voltage(s) by disconnects/circuit breakers/isolation switches, and it has been verified that there are no voltages present.

C. Large capacitors exist in the Intermediate DC Circuit. A properly sized discharge circuit is incorporated in all drives and should not be modified. It is designed to discharge the Bus voltage to less than 50 V DC within one minute. However, a power capacitor with even a small charge remaining is potentially lethal. If the discharge circuit has malfunctioned, discharge capacitors through a properly sized resistance.

WARNING: Discharging a voltage as low as 20 VDC by shorting the capacitors still causes a considerable discharge current and is potentially lethal.

D. To verify that no voltage is present, a measurement must be taken at the Intermediate DC bus. The measurement should be made starting with the 1000V DC range of a multimeter, then switching to lower voltage ranges as voltage level permits to prevent over-range readings.

E. Many voltage testers are unsuitable for checking the Intermediate DC Circuit voltage, because they do not respond to voltages below approximately 100V DC.

WARNING: When Voltage is supplied to the inverter, a potentially Fatal Voltage is present between the cards and the inverter chassis!

Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn or unintended actuation of controlled equipment. Recommended practice is to disconnect and lock out control equipment from power sources and confirm discharge of stored energy in capacitors, if present. If it is necessary to work in the vicinity of energized equipment, only qualified personnel should be permitted to perform such work, using all applicable safety practices and protective equipment.

DO NOT needlessly remove the aluminum and plastic protection panels during fault tracing. This is usually unnecessary and can expose personnel to potential hazards from voltage sources present in the unit.

Always replace protective panels before operating the unit.

Chapter 2 – Hardware Overview

Introduction

Information included in this section is intended to provide maintenance personnel with a basic understanding of the major hardware components associated with the SAMI STAR Drive.

Hardware Description

The Drive consists of the major hardware units in various configurations as described in Chapter 1, Introduction. In this section, each of the general modules associated with scalar drive configurations will be discussed in detail. Refer to the hardware schematics for your particular drive application to determine which of the hardware configurations and units have been supplied.

A summary of the modular units and their abbreviations is provided in Table 2-1.

Table 2-1 Unit Abbreviations

Module	Abbreviation
Contactor Unit	CTU
Line Converting Unit	LCU
Capacitor Bank Unit	CBU
Line Rectifier Unit	LRU
Line Supply Unit	LSU
Inverter Unit	INU

Three phase AC power is supplied to the Drive through the Contactor Unit (CTU). The CTU contains a disconnect, line fuses, and relay contacts which control the application of power to the Line Converter Unit (LCU). The LCU consists of a simple six diode, three phase rectifier bridge which provides a constant DC output voltage. This voltage is filtered by means of a DC choke and the Capacitor Bank Unit (CBU).

The CBU filters the DC voltage to provide a constant DC voltage source to the Inverter Unit (INU). In drive applications where GTO devices are used (units above 115 kVA) in the INU power bridge, there will be a DC fuse(s) between the CBU and INU.

The DC voltage from the CBU is converted to controlled three phase AC voltage and frequency by the INU. The three phase output from the INU is applied to the AC motor to control the speed and torque. All control cards are provided to control the turn on, and turn off of the INU bridge devices.

Reference and logic control inputs to the INU are provided either from a local Control Panel, an external device such as the System Controller via Serial Communication from other I/O Cards.

Figure 2-1 provides a detailed overview of the major hardware components associated with a Scalar Drive.

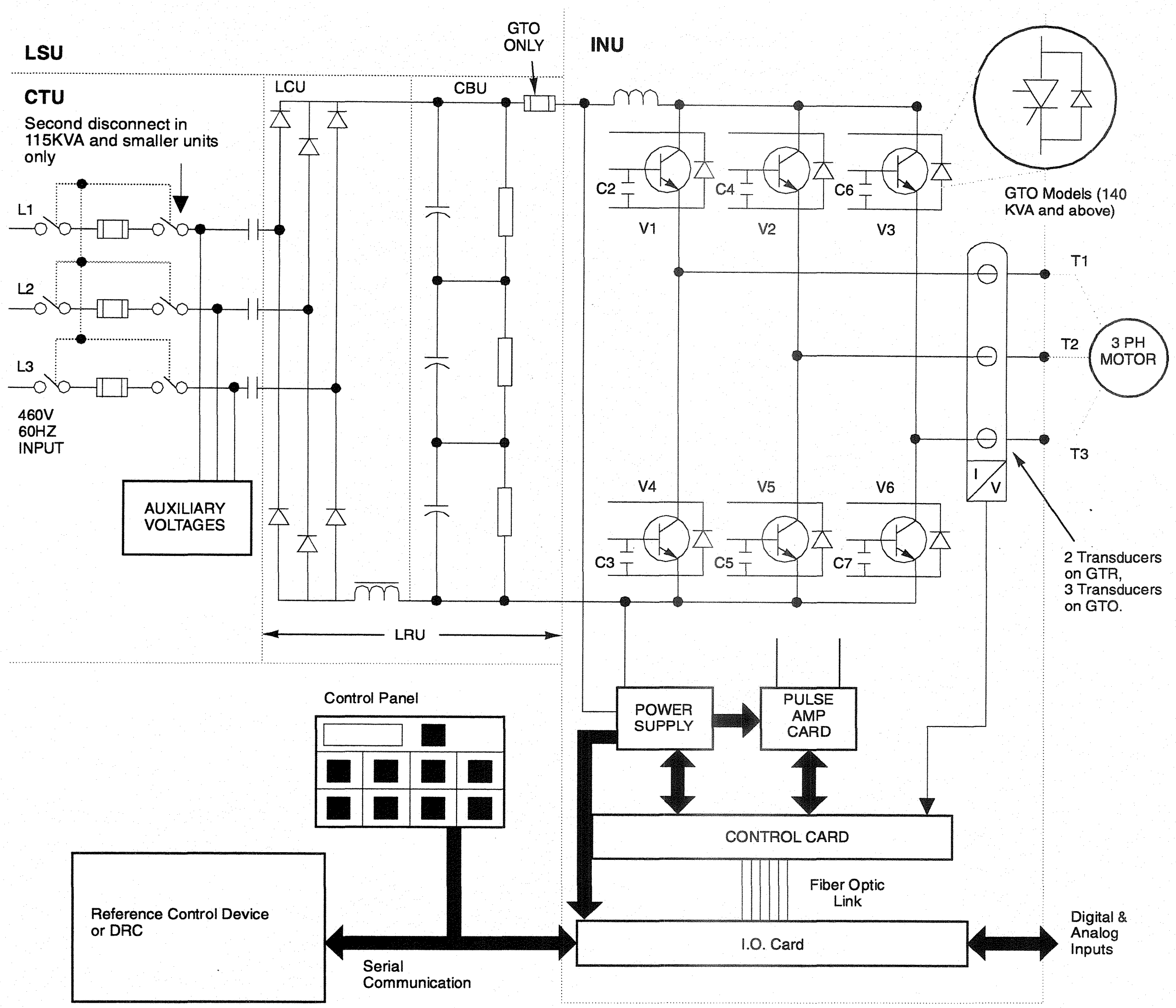


Figure 2-1 SAMI STAR Block Diagram

Contactor Unit (CTU)

The Contactor Unit (CTU) performs the function of controlling the application of the three phase input line power to the Drive. The CTU is sized based on the total power requirements of the application. The CTU consists of a main disconnect switch fuses, contactors and relays (Figure 2-2). There are two functions performed by the CTU relay logic. The main contactor (K1) controls the application of three phase power directly through the CTU. This power is then applied to the Line Converter Unit (LCU). A precharge relay allows power to flow from two of the three phases on initial energization of the Drive system in order to precharge the capacitors located in the Capacitor Bank Unit (CBU).

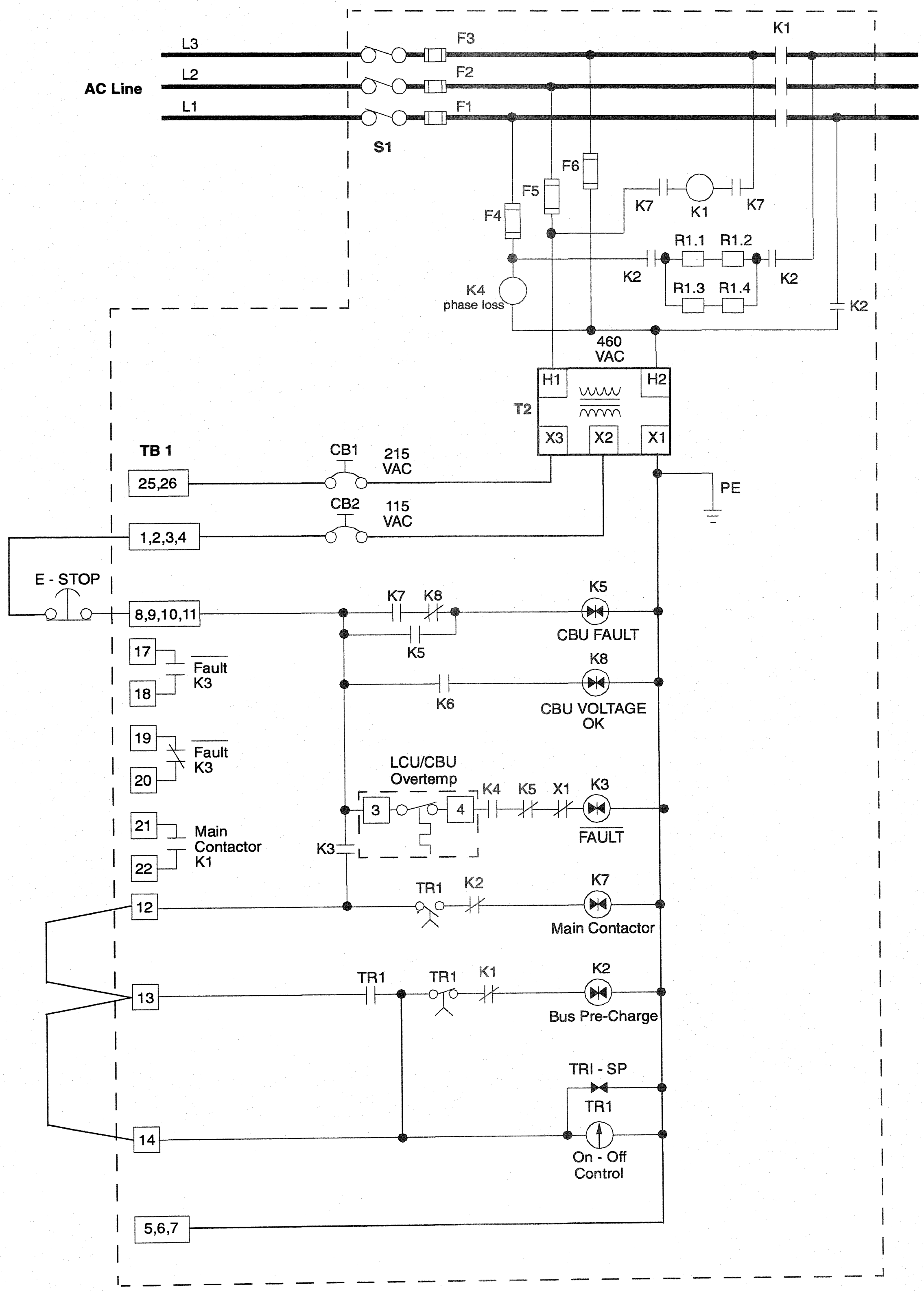


Figure 2-2 Typical Contactor Unit Logic

When main disconnect S1 is closed, the Phase Loss relay K4 is energized and power is supplied to control transformer T2. Relay K4 is connected to the three phase supply immediately after the fuses but on a different phase than the control transformer, so that if one phase is open, either K4 or T2 will be de-energized, shutting down the Drive. T2 provides 115V AC for the control circuit and 215 VAC to the Inverter Unit (INU). If no faults exist when power is applied, relay K3 is energized. With K3 energized, precharge timer TR1 and contactor K2 are energized. Contacts from K2 supply singe phase AC through resistors R1 to the LCU which charges the DC bus CBU. The setting for TR1 should be a minimum of 0.5 seconds to allow sufficient time for the DC bus to charge. If the bus does not charge to a high enough level, fuses F1, F2 & F3 may open when the main contactor K1 is energized. When TR1 times out, it opens K2 and energizes K1 which applies full three phase line voltage to the LCU.

The externally operated Disconnect Switch supplied on all units allows the Drive to be disconnected from the AC power supply before gaining access to the cabinet internals. The handle is interlocked to guard against entry to the enclosure while the switch is engaged. If desired, the disconnect can also be padlocked to guard against unauthorized entry.

WARNING: Depending upon the KVA rating of your unit, power is applied to the incoming line fuses in different arrangements. **DO NOT** attempt to service this unit or to connect other equipment to this unit until you completely understand the incoming line connections. Failure to adhere to this warning may cause **CATASTROPHIC** damage to the equipment or **FATAL** injury to the operator.

If maintenance must be performed with power ON, a defeater mechanism is provided to allow entry to the cabinet without turning off the power.

WARNING: If the defeater mechanism is used, and power is supplied to the Drive, a potentially fatal voltage is present between the cards and the inverter chassis. Only qualified service or maintenance personnel familiar with the Drive should attempt to use the defeater mechanism during service or set-up.

Line Converter Unit (LCU)

Figure 2-3 illustrates the hardware contained in the LCU. The LCU uses a 6 pulse diode bridge to convert the incoming three phase AC power to DC.

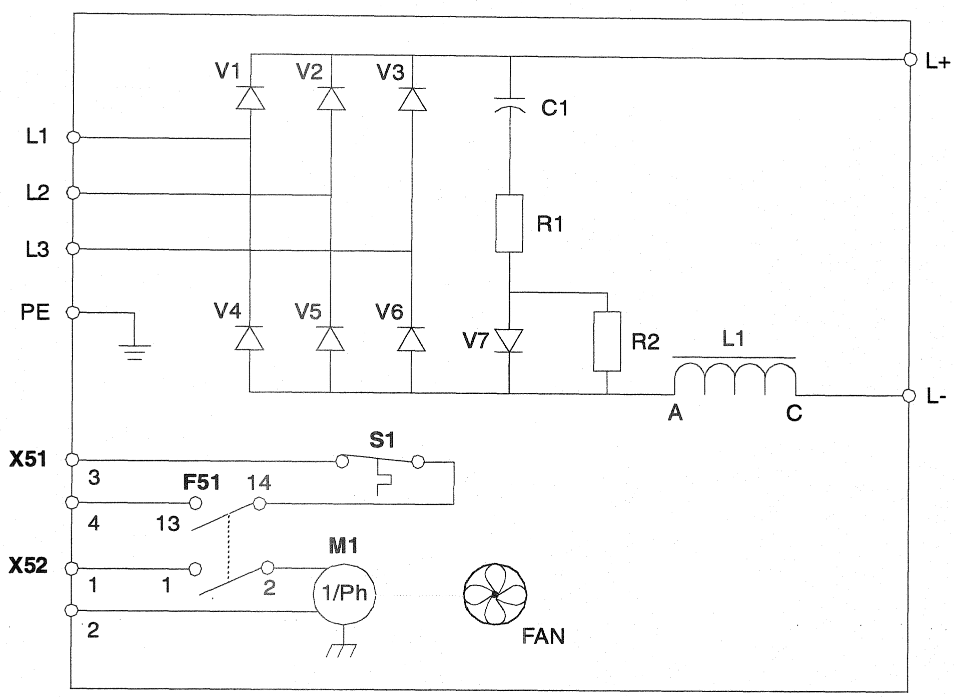


Figure 2-3 Line Converter Unit (LCU)

The LCU is equipped with a fan for cooling and a thermal switch(S1) to protect against over temperature. On 210 kVA units and larger, the fans and thermal switch have a manual switch (F51) in their circuits that is open when the units are shipped. This switch is located near the fan, at the bottom of the LCU cabinet. The switch must be closed before the unit is started up to provide power to the fan from the 215 V AC bus and allow K2 in the CTU to close.

The DC choke (L1) is provided to filter the ripple from the diode bridge and along with the CBU, provides a smooth DC voltage to the inverters.

The RC snubber circuit in parallel with the diode bridge guards against temporary overvoltage or voltage spikes by limiting the rate of change of DC voltage. The bi-polar design reduces losses in the resistors during normal operation.

Capacitor Bank Unit (CBU)

The CBU consists of banks of electrolytic capacitors to both filter the DC ripple from the diode bridge and provide a source for reactive current. Figure 2-4 illustrates the hardware contained in the CBU. For 460V input, 3 banks are connected in series; for 575V input, 4 banks are connected in series.

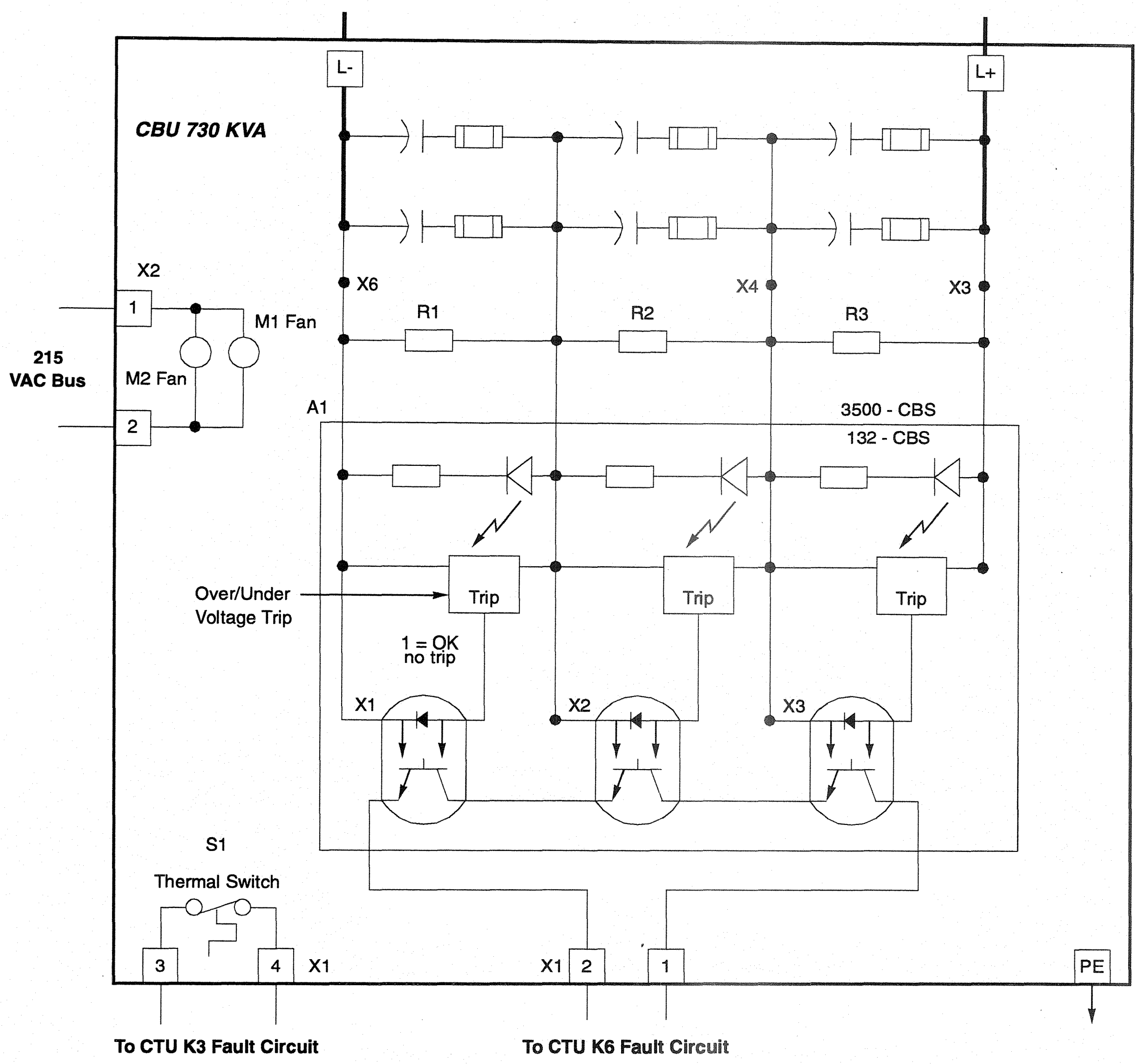


Figure 2-4 Typical Capacitor Bank Unit

On units larger than 300 kVA, each of the capacitors are fused for protection. These CBU's also have thermal switches for over temperature protection wired into the CTU K3 Fault circuit. The units are equiped with a fan or fans for cooling. The power for the fan(s), is provided from the 215VAC bus. Each fan is thermally protected, but not interlocked with the K3 fault circuit. The fans should be checked periodically for proper operation.

Discharge resistors R5, R6 and R7 are provided to balance the voltage across the capacitors and discharge the capacitors when power is removed. The resistors are sized to discharge the DC bus to below 50 volts in one minute per NEMA standards. The bus voltage must always be checked before allowing anyone to work on the unit.

WARNING: Discharging a voltage as low as 20V by shorting the capacitors still causes a considerable discharge current and is potentially lethal. Remember even though the CBU Supervisory Card LED may be extinguished this is NOT a true indication that the bus is totally discharged.

Line Rectifier Unit (LRU)

The Line Rectifier Unit (LRU) is used on 210 kVA through 290 kVA drives and consists of an LCU and CBU physically packaged in a single unit. Figure 2-5 illustrates the basic configuration of the hardware associated with the LRU.

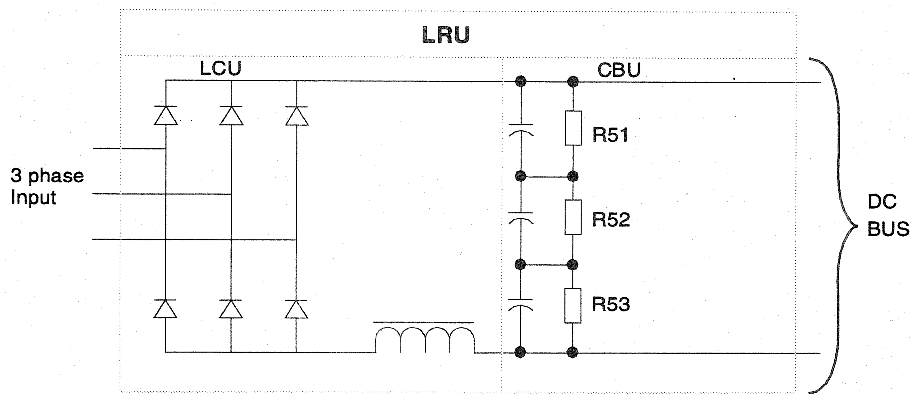


Figure 2-5 Line Rectifier Unit (LRU)

Line Supply Unit (LSU)

The Line Supply Unit (LSU) is used in drives rated 180 kVA and below. It is comprised of the Contactor Unit (CTU). Line Converter Unit (LCU), and Capacitor Bank Unit (CBU). Figure 2-6 illustrates the basic configuration of the hardware associated with the LSU.

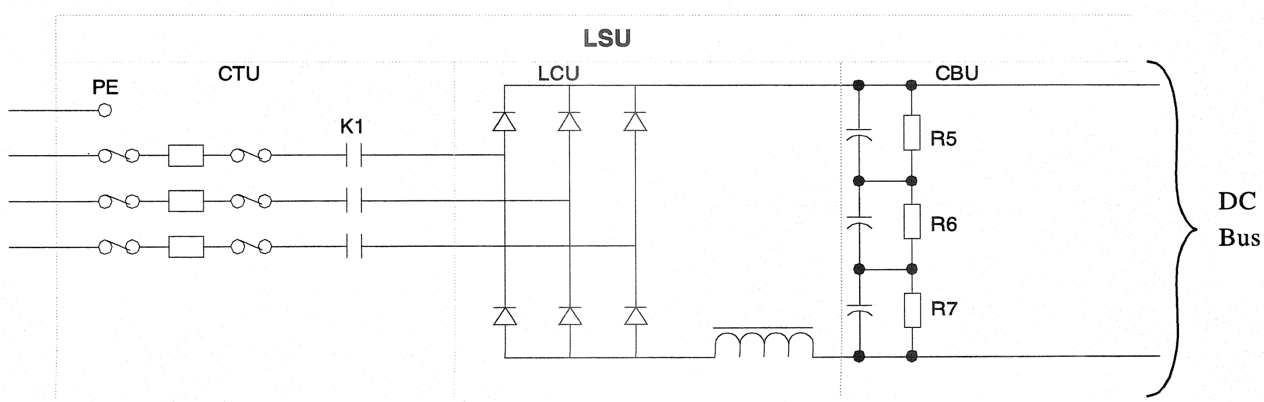


Figure 2-6 Line Supply Unit (LSU)

Inverter Unit (INU)

The INU converts the DC voltage to an AC voltage and frequency controlled Pulse Width Modulated (PWM) waveform which is then applied to the AC motor. Figure 2-7 provides an overview of the major hardware components associated with the INU. There are two versions of the INU. Units of 115 kVA or less use GTR transistors as power devices and units 140 kVA and above use GTO thyristors for power devices.

The Control Card is the major component of the INU. A micro-processor contained on this card performs the control functions required to generate the firing pulses for the power bridge devices. Reference and feedback information is supplied to the Control Card from other cards in the INU.

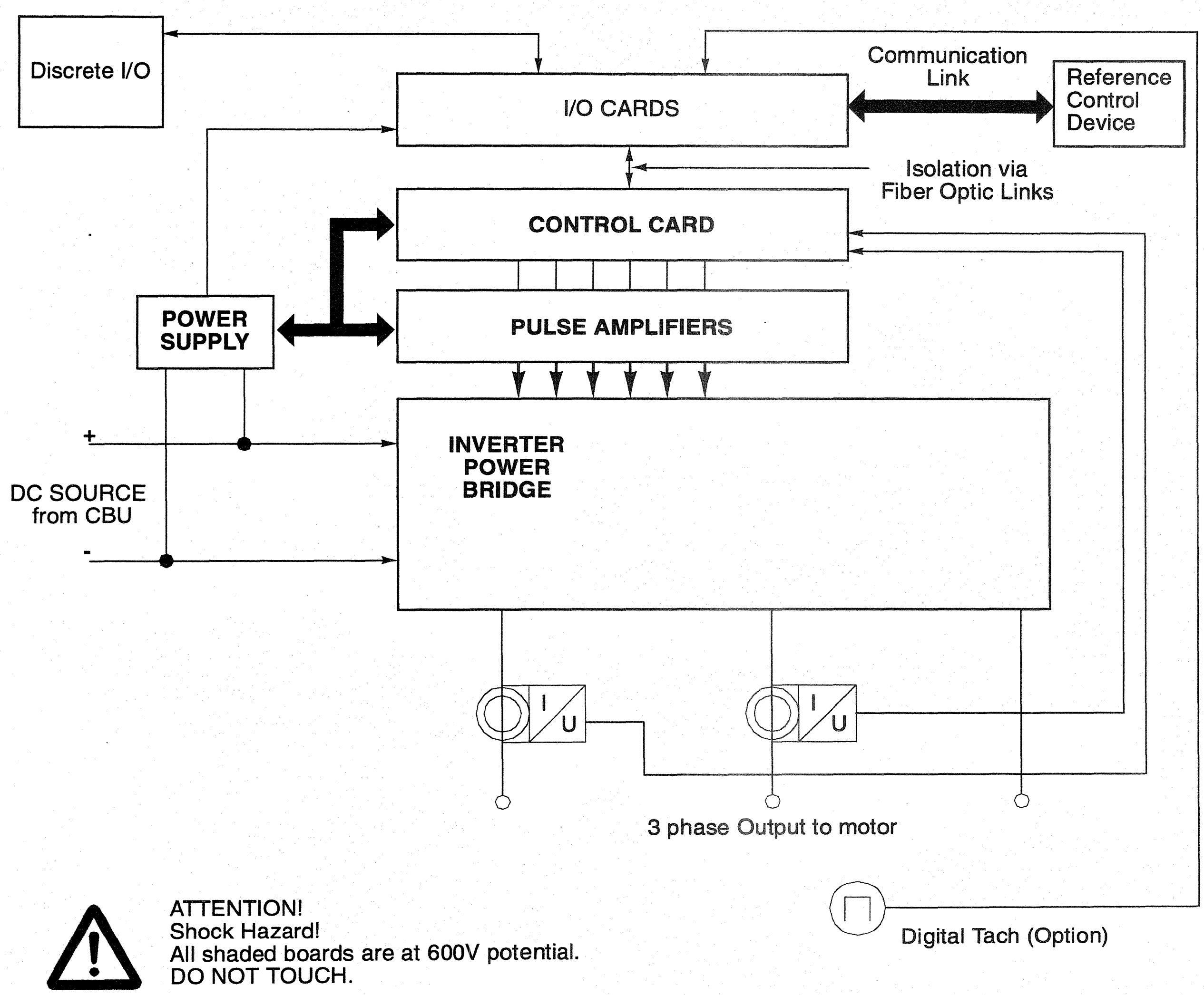


Figure 2-7 Inverter (INU) Block Diagram

The I/O Cards (Input/Output) provide for the interface between the Control Card and devices external to the INU. Various possible combinations of I/O Cards and Terminal Block Cards may be supplied depending on the specific application requirements. Information flow between the Control Card and the I/O Cards is accomplished using galvanically isolated fiber optic communication.

Devices external to the INU Control Card may include a reference control device such as a local or remote Control Panel. As a stand alone unit, discrete I/O such as start, stop, etc. may be brought into the Drive through the I/O cards.

The Power Supply provides control power to other control cards in the INU. DC control voltages are provided to the Control Card and the Terminal Block Card. In addition, the Power Supply provides power to the Pulse Amplifier Cards which in turn generate the gating pulses to the power bridge devices. Input to the Power Supply is derived directly from the DC bus which allows the control power ride-through capability during momentary power outages.

If the DC bus is not energized, the power supply will derive its power from the 215 V AC bus via an auxiliary power supply. This provides a means of powering the Control Card upon initial power up and in the event that the DC bus is not powdered Once the DC bus is powered, all control power in the INU is provided from the DC bus.

In the GTR units, the auxiliary power supply circuits are located on the Power Supply Card. However, in GTO units, a separate Auxiliary Power Supply Card is used.

The Pulse Amplifier Cards receives signals from the Control Card. These signals are amplified and applied to the power bridge devices. There are two different types of Pulse Amplifier Cards. In GTR units, a single Pulse Amplifier Card provides amplification of all six signals. In GTO units, there is a separate Pulse Amplifier Card for each phase.

GTR Power Bridge

Figure 2-8 illustrates the components associated with the GTR Inverter Unit. The power semiconductor devices of the GTR unit are contained in galvanically isolated modules. In 30 kVA and 50 kVA and 115 kVA drives, there is one of each device per module.

The power devices are protected against rapid rate of current changes through the use of reactor L1. Protection against voltage transients is provided through the use of capacitor snubber circuits. After commutation, the excess energy stored in the reactor L1 is transferred through diodes V14, V15, and V16 to the clamping capacitor C1. The capacitor is then discharged to the DC input side of L1 through resistor R1.1

Current feedback information is provided to the Control Card through the use of Hall-Effect current transducers. Two phases of current feedback are necessary to perform the control function. Information on the level of the DC bus voltage is supplied to the Control Card from the Power Supply. In optional vector control applications, a tachometer feedback signal is sent to the Control Card through the Terminal Block Card and I/O Connection Card.

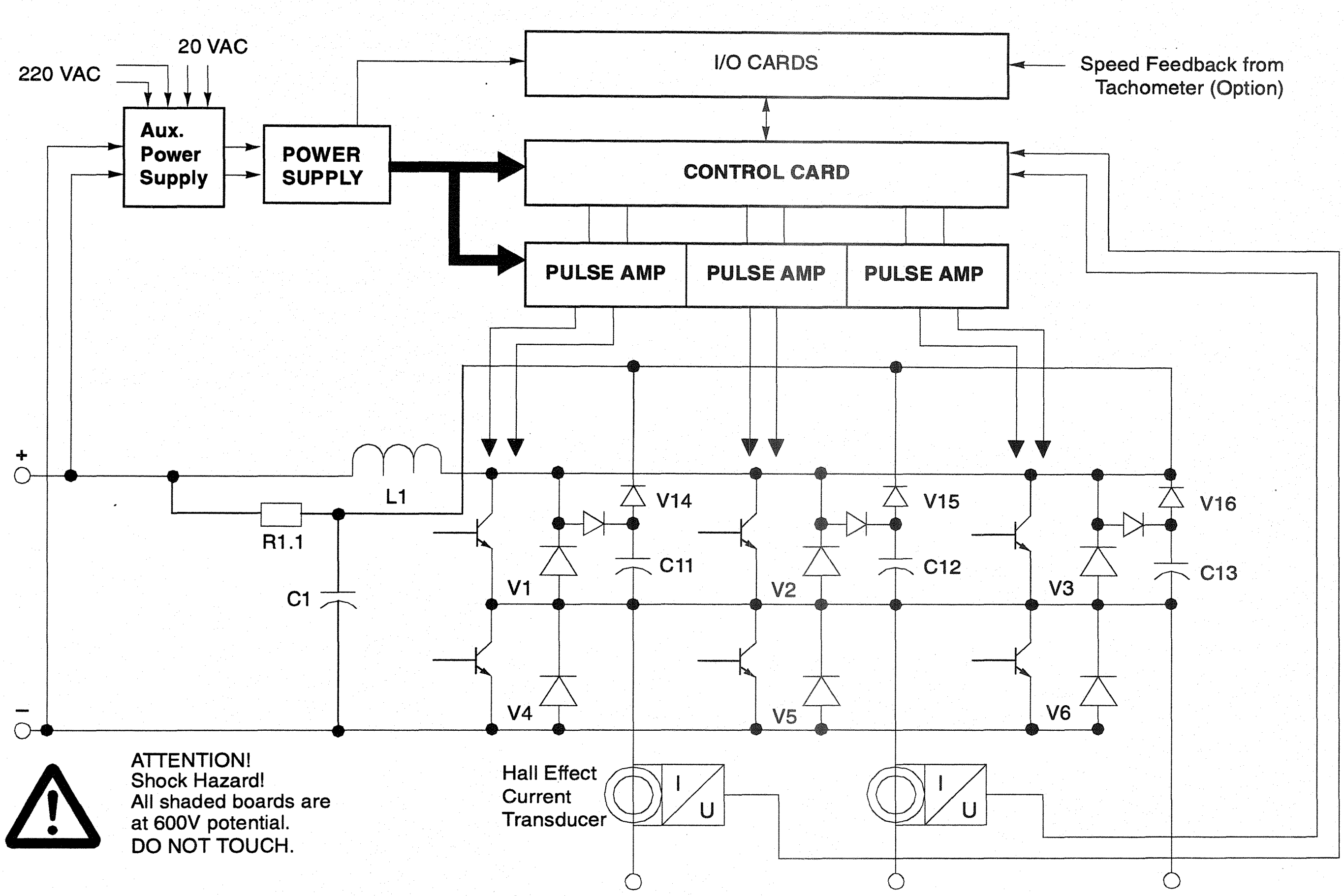


Figure 2-8 GTR Inverter Block Diagram

The inverter unit is protected against overtemperature, overcurrent, short circuit, overvoltage and undervoltage. The self diagnostic feature of the control cards checks the condition of power semiconductors, measuring transducers. pulse amplifiers and control logic after the supply voltage has been switched on. In the event of an overtemperature, overcurrent, short circuit or abnormal voltage reading, the power transistors are switched off.

GTO Power Bridge

Figure 2-9 illustrates the components associated with the GTO Inverter Unit. The power semiconductor devices of the GTO unit are presspack type Gate Turn-Off (GTO) thyristor devices. Freewheeling diodes are supplied as separate presspack devices.

The power devices are protected against rapid rate of current changes through the use of reactor L1. Voltage protection is provided through the use of capacitor snubber circuits C1, C2 and C3. After commutation, the excess energy stored in the reactor L1 is transferred through diodes V24 through V27 to the clamping capacitor C9 and the chopper circuit. GTO V17 controls the flow of energy back to the DC input side of L1. Gating of V17 is controlled by the Chopper Control Card. The additional circuitry associated with the chopper is an additional snubber capacitor and free-wheeling diode network.

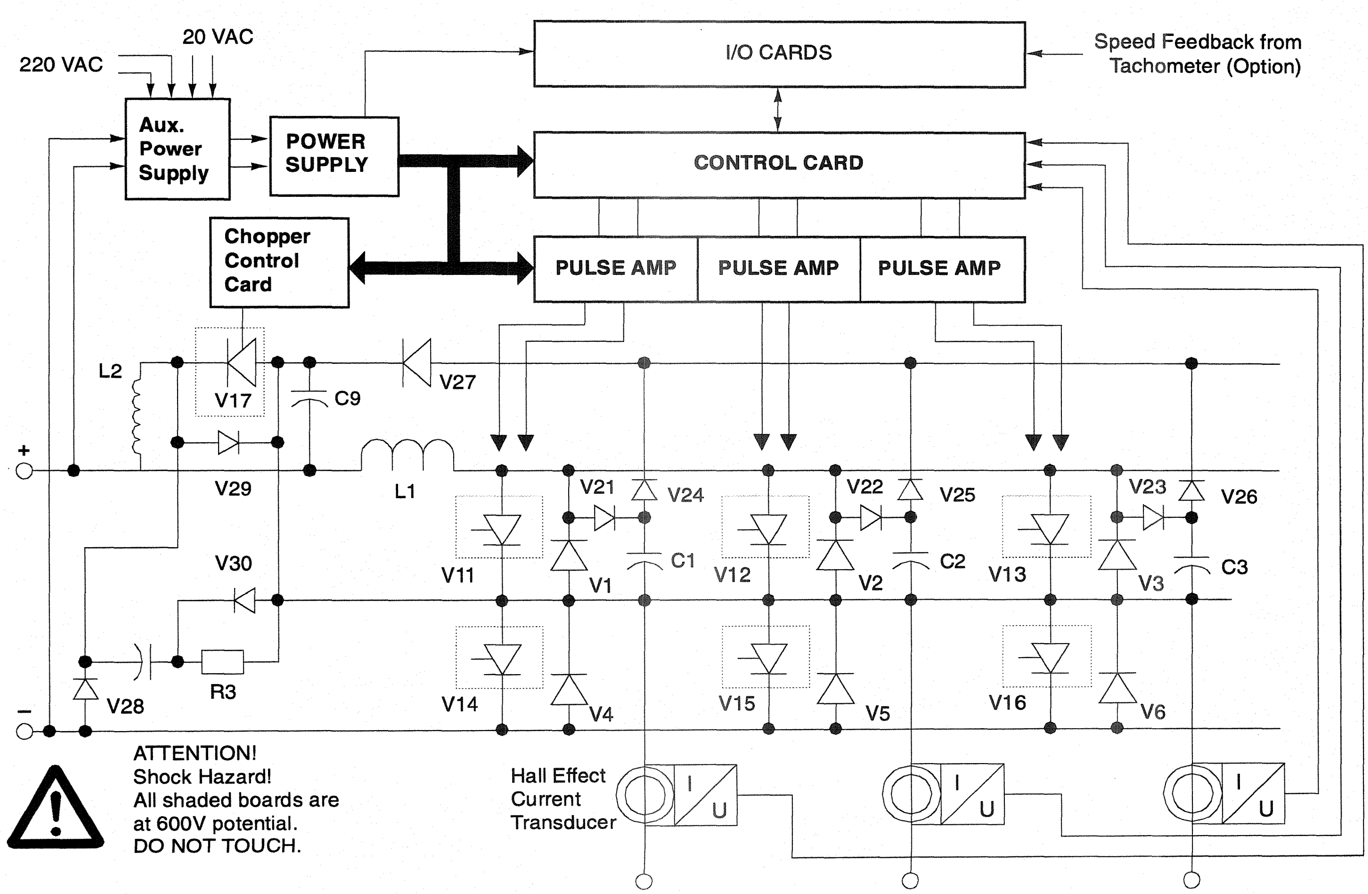


Figure 2-9 GTO Inverter Block Diagram

Current feedback information is provided to the Control Card through the use of Hall-Effect current transducers. Only two phases of current feedback are necessary to perform the control function. A third Hall-Effect feedback device is added for overcurrent protection. Information on the condition of the DC bus voltage is supplied to the Control Card from the Power Supply Car

The self diagnostic feature of the SAMI STAR checks each GTO unit on power up, in addition to checking the transducers, DC chopper, pulse amplifiers, short circuit, ground faults and control logic. If a fault is detected, starting is inhibited and a fault message appears on the Control Panel. When a fault condition occurs while running, the GTOs are turned off.

30 KVA to 115 KVA Units

The 30 kVA to 115 kVA units are supplied as standard in a single bay enclosure. The cabinet is 92 inches high, 26 inches wide, and 26 inches deep constructed of 12-gauge metal painted beige. Mounted in the door of the enclosure is the CP-1 Control Panel. Next to the Control Panel is the Emergency Stop Push-button that interrupts the power to the control circuits. The Emergency Stop Push-button will disconnect control power and cause the motor to coast to a stop. This is a maintained position push-button, so that the drive cannot be restarted until the button is pulled out again. The PE and TE ground buses are located in the front of the enclosure at the very bottom. PE is used as the cabinet ground and TE is used as the common for the cable shields. Both of the buses are copper that have been plated to reduce corrosion.

Facing the front of the cabinet, the Line Supply Unit (LSU) is on the right. Located on the bottom left of the LSU is the A14 Terminal Block Card which provides the interconnections to the Inverter Unit (INU). Located on the right of the LSU near the bottom is the Contactor Unit (CTU) terminal block TB-1 that interconnects the relay and contactor circuits.

The AC supply lines enter the unit at the top right and connect to the terminals at the top of the main disconnect, just above the main fuses. The handle rod for the disconnect switch connects with the handle on the door. The Main Contactor (K1) is located below the disconnect, with the Line Converter Unit (LCU) on its left. The LCU rectifies the incoming AC voltage to DC using a six diode bridge mounted on a heatsink. A thermal switch (S1) is mounted at the top of the heatsink. Located below K1 are fuses F4 through F6. These fuses are the input fuses for the control transformer and the precharge circuit, while circuit breakers CB1 and CB2 are the transformer secondary protection. Located behind the metal panel, are the precharge resistors. The Relay Output Card A11 is mounted on the face of the metal panel. The relays and the timer for the CTU are located below the fuses. The DC bus capacitors are mounted behind the LSU panel.

INU Module

The module located on the left is the Inverter Unit (INU). The printed circuit board at the top of unit is the Control Card A2. Mounted on the Control Card is the Matching Card A2.1 which matches the voltage and current ratings of the Drive to the program parameters. A different Matching Card is used for each Drive voltage and current rating. The Control Card contains the microprocessor and memory chips for the specific application.

IMPORTANT: *If the Control Card is replaced, the memory chips D16, D17, & D18 must be removed and inserted on the replacement card. Memory chips cannot be interchanged between 187 CON and older cards.*

Located below the Control Card is the A1 Connection Card which is connected to the Control Card through fiber optic cables. The mounting for the optional A13 Analog I/O Card and optional A15 Analog Input Card is on the top of the A1 Connection Card. All of these cards are mounted on a swing-out door.

The Control Cards for the Inverter Unit (INU) are mounted on a door that can be opened for access to other components mounted inside the INU. The Power Supply Card A3 is mounted on the back of the door. All the connections to the door mounted cards are at the hinge side and the cable routing is such that the flexing of the cables is minimized by having them run parallel to the hinge. Located on the back panel is the A4 Pulse Amplifier Card. The Pulse Amplifier Card part number depends on the rating of the Drive.

WARNING: Care must be taken when door is swung out with the power ON. Components on the Control Card are at negative bus potential and can come in contact with the ground frame of the inverter causing hazardous conditions, including damage to components.

Located behind the Pulse Amplifier Card are the Giant Transistor Modules (GTRs) with their snubber capacitors and diodes. At the top of the GTRs is the heatsink thermal switch. At the bottom of the unit, in-line with the bottom of the swing panel, are the Hall Effect current transducers and the terminals for the motor leads marked U2, V2 and W2. To the left of the motor terminals is the manual switch for the INU fan. This switch must be in the "ON" position for the Drive to operation. The fan is located behind the motor terminals.

INU Cutaway View (115 KVA and Smaller)

Figure 2-10 shows a cutaway view of the GTR Inverter Unit. All components are board locations are marked with the identification as used in the diagram and on the components. A copy of this drawing is also show on the clear plastic shield on the inverter module.

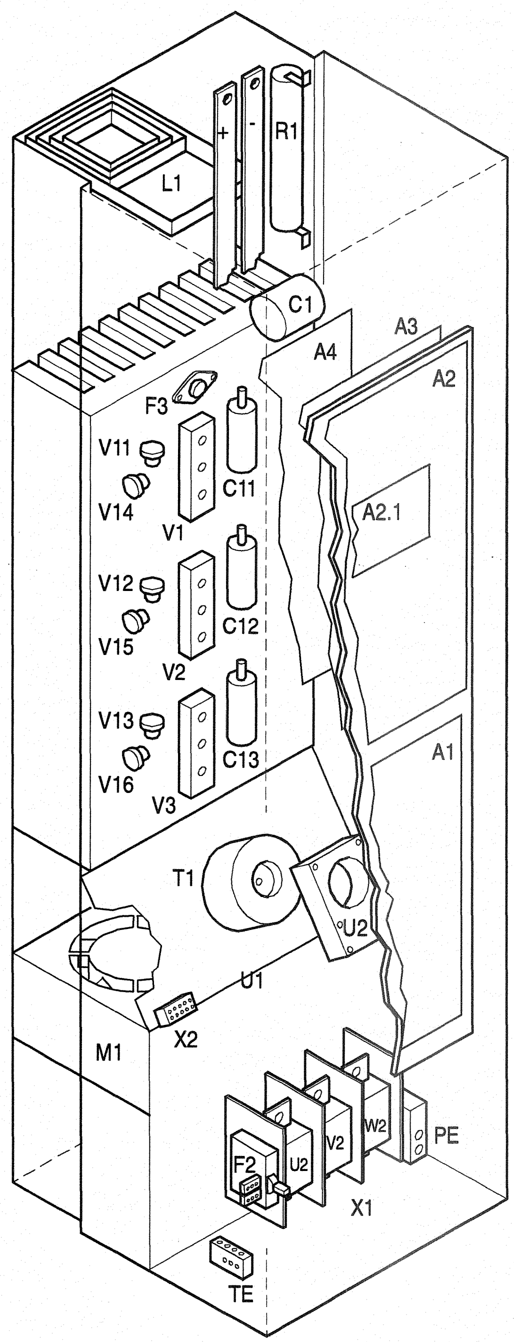


Figure 2-10 INU Unit (115 kVA and smaller)

140 KVA and Larger Units

The 140 kVA and larger kVA units are supplied as standard in a single, double and triple bay enclosures depending upon current ratings. The cabinet dimensions are listed in Table 3-1, Chapter 3. The enclosure is constructed of 12-gauge metal painted beige. The contactor, line converter, and capacitor bank units are similar to the smaller units, their functions have already been described in the previous section.

GTO Inverter Module

The Inverter Unit (INU) for the larger Drives contains the same control cards as the smaller unit. The card mounted at the top is A1 of the unit is the Input Connection Card. Below that is the A2 Control Card, again connected to the Input Connection Card with fiber optic cables. The Matching Card is attached to the Control Card. Behind the Control Card and the Input Connection Card are the three Pulse Amplifier Cards A4, A5 and A6. The part numbers vary according to the current rating of the Drive.

These five cards are mounted in a "cradle" which can be taken-out by removing the connectors and the four bolts, two on each side.

With the cradle removed the A3 Power Supply Card is exposed (part number varies with voltage and current). Behind the Power Supply Card is the A7 Chopper Control Card. The small card below the Power Supply Card is the A9 Aux. Power Supply Card which is used only on the 140 kVA and larger units. To the right of the Aux. Power Supply Card is the manual starter switch F11 for the INU fan at the bottom of the module. This switch must be in the "ON" position for the unit to operate since it also supplies the DC Power Supply until the DC Bus is charged. The overload current trip point is adjustable by means of a Trim potentiometer located on the switch. This timer is adjusted to allow for adequate motor protection.

The motor terminals are located at the bottom of the enclosure and are labeled U2, V2 and W2. With the cards removed, the GTO modules are in the upper portion of the module. A thermal switch is located on the top of the heat sink near the center. Each module has the GTOs located on the sides with diodes near the center. Between the two diodes are the snubber capacitors. The stud mounted diodes are part of the snubber circuit.

GTO INU Cutaway Views (140 kVA Units and Larger)

Figures 2-11 and 2-12 show cutaway views of the Chopper and GTO Inverter Unit. All components and board locations are marked with the identification as used in the schematic diagrams. A copy of these drawings is also shown on the clear plastic shield on the inverter module.

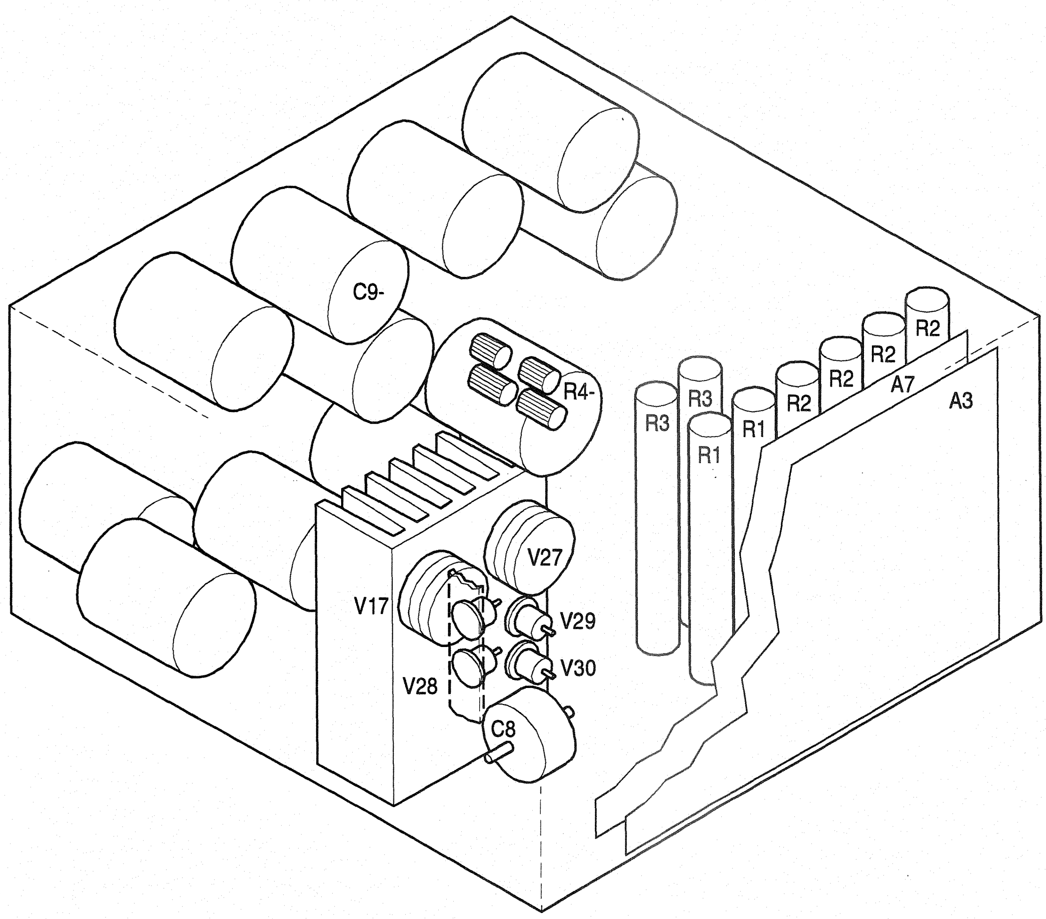


Figure 2-11 Typical Chopper Module

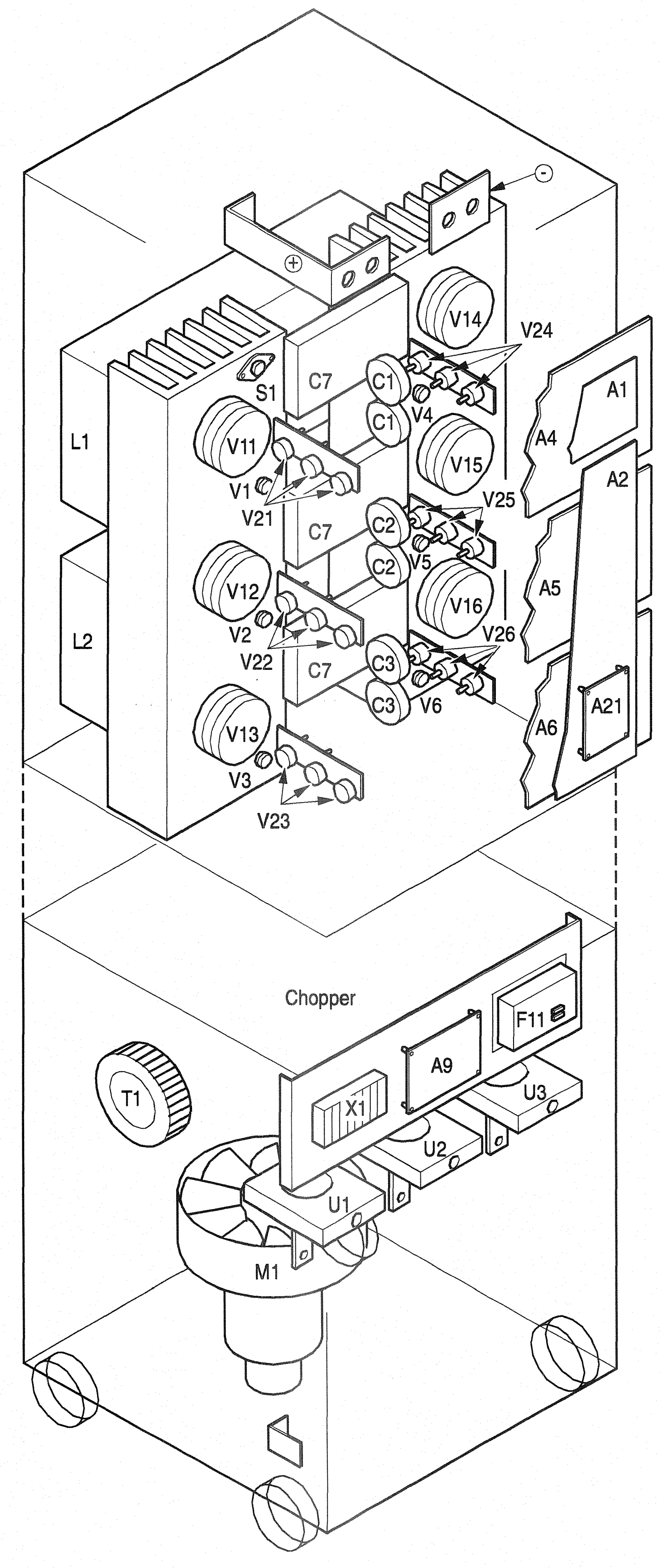


Figure 2-12 GTO Inverter Module

Board Diagrams & Descriptions

Control Card SAFT 187 CON

Figure 2-13 illustrates the general layout of the Control Card. The basic hardware on the control card (with the exception of software chips related to Scalar or Vector control) remain the same on all Drive applications.

IMPORTANT: *The control card is normally supplied and stored without the Firmware Chips D17 and D18.These Chips must be transferred from the board being replaced. Software Chip D16 is normally shipped in an unprogrammed state. The software must be transferred to the D16 chip from the board being replaced or by reprogramming the Drive. Software and firmware cannot be transferred to and from the 187 CON and older cards.*

Galvanic isolation of signals coming into the Drive from external devices is accomplished through use of fiber optic serial communication link between the Control Card and the I/O Cards. Devices V1 through V6 provide for connection of several fiber optic links. The fiber optic cables must have the proper connectors to mate with the devices on the Control Card.

Power supply inputs are through 20 lines of the 40-pin ribbon cable connected to connector X1. The other 20 lines of this connector are used for the gate pulse signal output from the Control Card to the Pulse Amplifier(s) and the GTO Chopper Control card when used. Connector X2 is a 40-pin ribbon cable connector which provides interface between the Control Card and the Matching Card.

Connectors X3 through X5 are used for current feedback information from the Hall Effect transducers. In the GTR units, only X3 and X4 are used. In the GTO units, all three connectors are used.

Connector X6 provides for analog outputs signals from 4 Digital to Analog (D/A) converters. Because the Control Card is at the DC Bus potential, the analog output signals are also at DC Bus potential. Therefore, in order to use the analog outputs, an optional hardware conversion unit, which provides isolation from the DC Bus potential, must be used.

The microprocessor D8 performs all functions on the Control Card with the exception of fault tripping, which is a hardware function. EPROM chips D17 and D18 contain the main operating program, and will be different depending on the specific type of control being used (Vector or Scalar) and the firmware revision provided. The Main Control Card uses 64K Eproms. Jumpers S5 and S6 should be set to A-C.

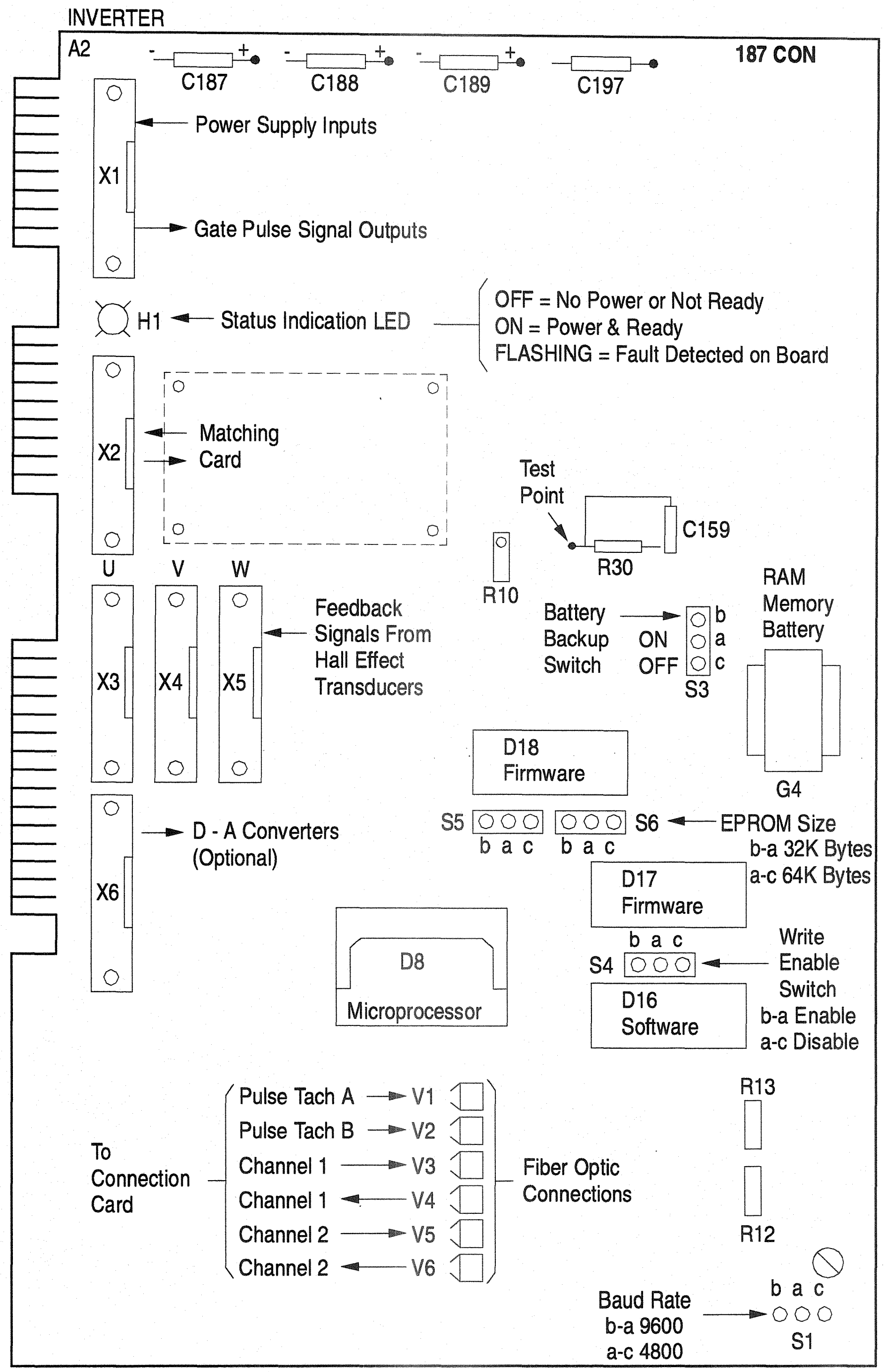


Figure 2-13 SAMI STAR Control Card

In addition to the parameter information stored in RAM (Random Access Memory), there are many parameters which are related to set-up and configuration of the drive which need to be retained in the event of a power loss.This type of memory is called EEPROM and is contained in D16. If the power is lost, all critical Drive set-up parameters will be retained in this memory. In addition to the EEPROM backup, there is a battery on the control card which maintains some of the RAM memory if power is lost.

Jumper switch S1 is used to set the baud rate for serial communication. Position a-b corresponds to 9600 baud and a-c corresponds to 4800 baud. Jumper switch S3 is used to disconnect the battery backup when the control card is in long term storage. When S3 is in the a-b position, the battery back-up is operational; when in the a-c position, battery backup is disabled.

S4 controls the write-enable function of the EEPROM backup. When S4 is in the a-b position, writing to EEPROM is enabled; when in the a-c position, writing is disabled. If EEPROM writing has been enabled by S4, backup of the Drive set-up parameters is controlled in software.

GTR Pulse Amplifier Card SAFT xxx GTR

The Pulse Amplifier Card contains the amplifier circuits for all six transistors of the GTR type Inverter Units. Each amplifier circuit uses a control signal from the Control Card to produce a base drive signal which is applied to the base of an inverter transistor. In addition to the base drive signal, each amplifier circuit provides for short circuit monitoring of the inverter output and protection of the amplifier circuit for each transistor in the event of a shorted transistor.

Table 2-2 shows the connections for the Pulse Amplifier Card.

Table 2-2 GTR Pulse Amplifier Card Connections.

Connector	Type	Purpose
X1	20 Pin Ribbon	Control signals and feedback signals from the control card
X2	4 Pin Plug	48V 80 kHz square wave from power supply
X1U	4 Pin Plug	Connection to GTR Positive U phase
X2U	4 Pin Plug	Connection to GTR Negative U phase
X1V	4 Pin Plug	Connection to GTR Positive V phase
X2V	4 Pin Plug	Connection to GTR Negative V phase
X1W	4 Pin Plug	Connection to GTR Positive W phase
X2W	4 Pin Plug	Connection to GTR Negative W phase

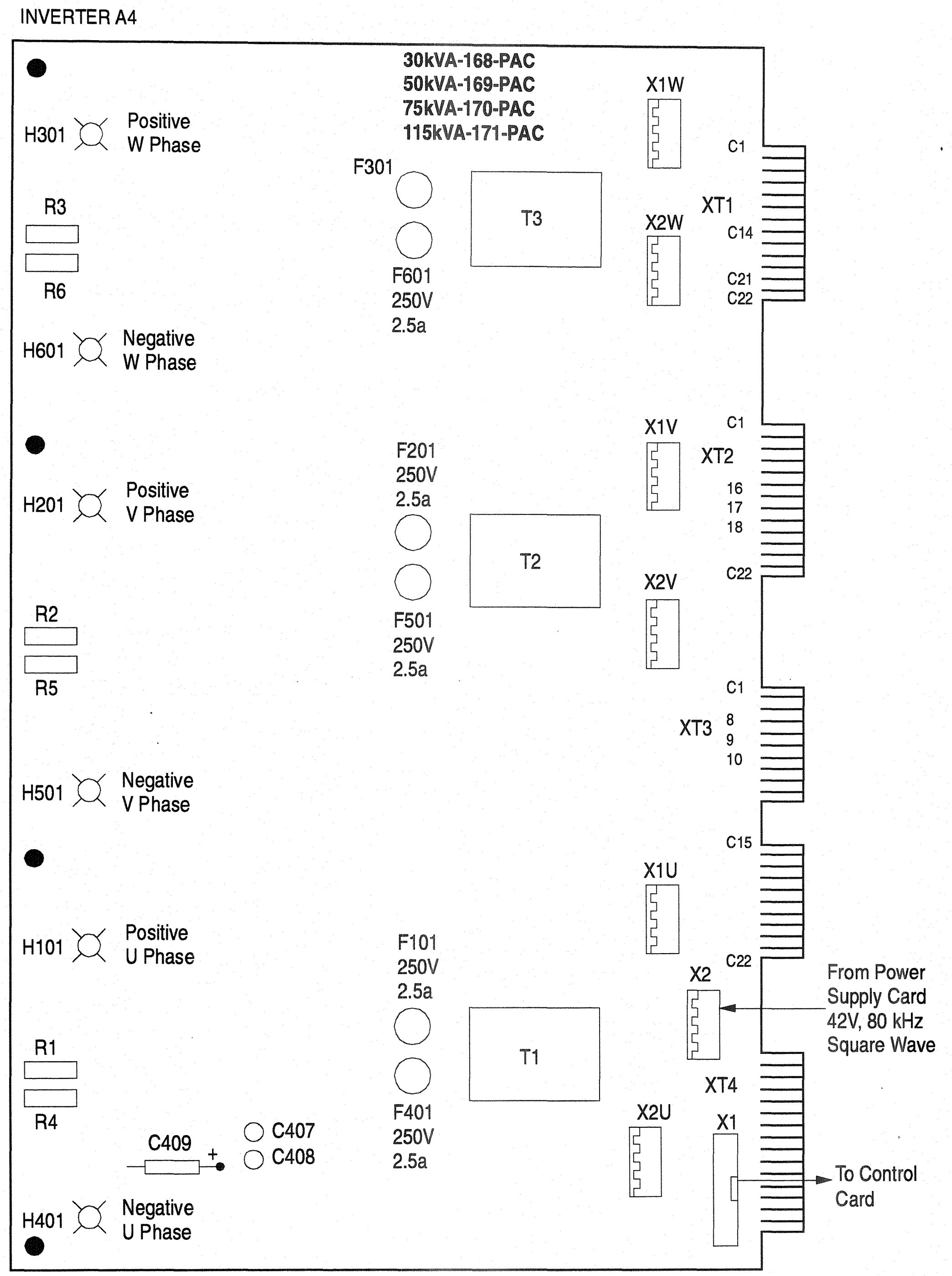


Figure 2-14 GTR Pulse Amplifier Card

IMPORTANT: No adjustments or switches on this card.

In the event of a short circuit on the output, the base Drive of the transistor is turned OFF. If a transistor is shorted, the associated fuse on the pulse amplifier card will open, protecting the amplifier circuit. Feedback information on the actual state of each transistor is returned to the control card and is indicated by an LED on the Pulse Amplifier Card, associated with each transistor. During normal operation, all LEDs on the card should be lit. If a fault occurs, the LED associated with the affected transistor will not be lit and the control panel will indicate a fault in that leg.

Table 2-3 shows the GTR Pulse Amplifier Card fuses and LED indications.

Table 2-3 GTR Pulse Amplifier Card Fuses and Indications

Fuse	LED	Purpose
F101		GTR Fuse Connected to X1U
F201		GTR Fuse Connected to X1V
F301		GTR Fuse Connected to X1W
F401		GTR Fuse Connected to X2U
F501		GTR Fuse Connected to X2V
F601		GTR Fuse Connected to X2W
	H101	Status of GTR Connected to X1U
	H201	Status of GTR Connected to X1V
	H301	Status of GTR Connected to X1W
	H401	Status of GTR Connected to X2U
	H501	Status of GTR Connected to X2V
	H601	Status of GTR Connected to X2W

GTO Pulse Amplifier Card SAFT xxx PAC

The Pulse Amplifier Cards associated with the GTO-INU perform a function similar to a GTR Pulse Amplifier card. A GTO unit however, requires three Pulse Amplifier cards. A shared logic circuit produces gate control signals for both GTO's and ensures that the two devices associated with a single output phase are not gated on simultaneously.

The gate control signals are sent to individual GTO pulse amplifier circuits. Signals between the logic and the amplifiers are optically isolated. The amplifier circuits produce the gate signals for each GTO and provide short circuit monitoring of the inverter output and protection of the amplifier circuit for each GTO.

If a short circuit on the output occurs, all GTOs are turned off. In the event of a shorted device, the fuse associated with the individual device will open, protecting the amplifier circuit. The logic on the card also detects a shorted GTO and prevents firing of the other GTO controlled by the card. Feedback information pertaining to the actual state of each GTO is returned to the control card and is indicated by an LED on the Pulse Amplifier Card. During normal operation all LEDs should be lit, if a fault occurs the LED associated with the affected GTO will not be lit. If GTO's are replaced. XG to XK should be checked to ensure gate turn off signals are present before charging the DC bus. Figure 2-15 shows a typical Pulse Amplifier Card with the amplifier circuits for the two GTO's associated with one phase of the output.

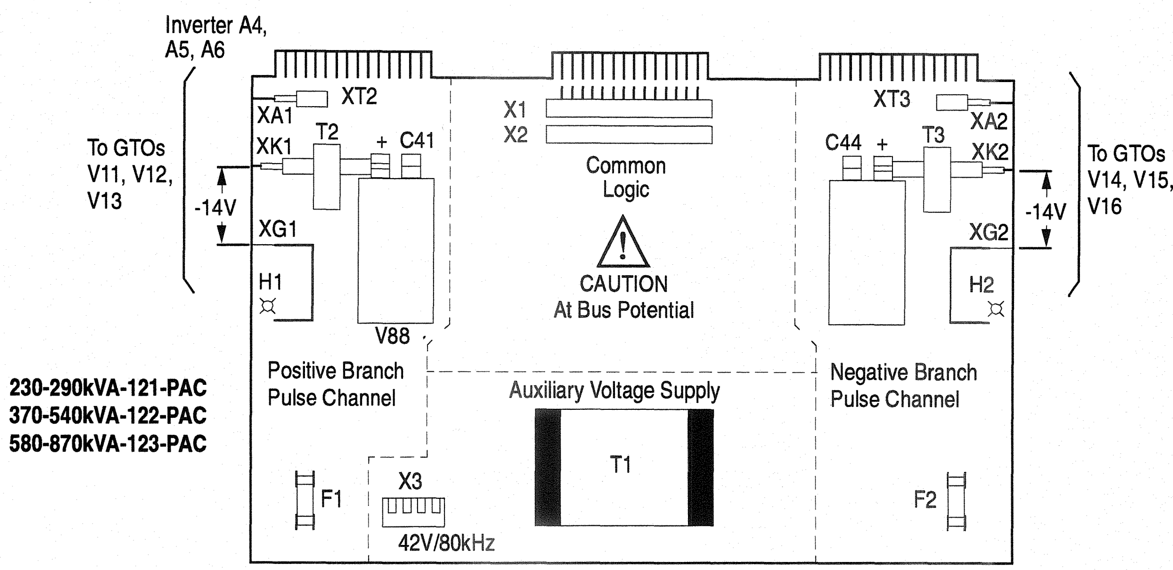


Figure 2-15 SAMISTAR, GTO Pulse Amplifier Card

WARNING! Check only with DC Bus discharged and the inverter disconnected from power.

Table 2-4 shows the connections for the Pulse Amplifier Card.

Table 2-4 GTO Pulse Amplifier Card Connections

Connector	Type	Purpose
X1	40 Pin Ribbon	Control Signal to and from Control Card
X2	40 Pin Ribbon	Control Signal to and from Control Card
X3	4 Pin Plug	42 V 80 kHz Square Wave from Power Supply
XA1	1 Pin Tab	Anode connection to GTO in Positive leg of Bridge
XG1	1 Pin Tab	Gate connection to GTO in Positive leg of Bridge
XK1	1 Pin Tab	Cathode connection to GTO in Positive leg of Bridge
XA1	1 Pin Tab	Anode connection to GTO in Negative leg of Bridge
XG1	1 Pin Tab	Gate connection to GTO in Negative leg of Bridge
XA1	1 Pin Tab	Cathode connection to GTO in Negative leg of Bridge

Table 2-5 shows the GTR Pulse Amplifier Card fuses and LED indications.

Table 2-5 GTO Pulse Amplifier Card Fuses and Indications

Fuse	LED	Purpose
F1		GTO Fuse in the Positive Leg of the Bridge
F2		GTO Fuse in the Negative Leg of the Bridge
	H1	Status of GTO in the Positive Leg of the Bridge
	H2	Status of GTO in the Negative Leg of the Bridge

GTR Power Supply Card SAFT 192 POW

Figure 2-16 illustrates the Power Supply used to supply voltage to both the Control Card and the Pulse Amplifier cards in the GTR-INU. The DC voltages used for control are normally derived directly from the DC bus. Upon initial power up, or if the DC bus voltage drops momentarily, a secondary source of power is provided to the Power Supply in the form of 220V AC from the INU control transformer.

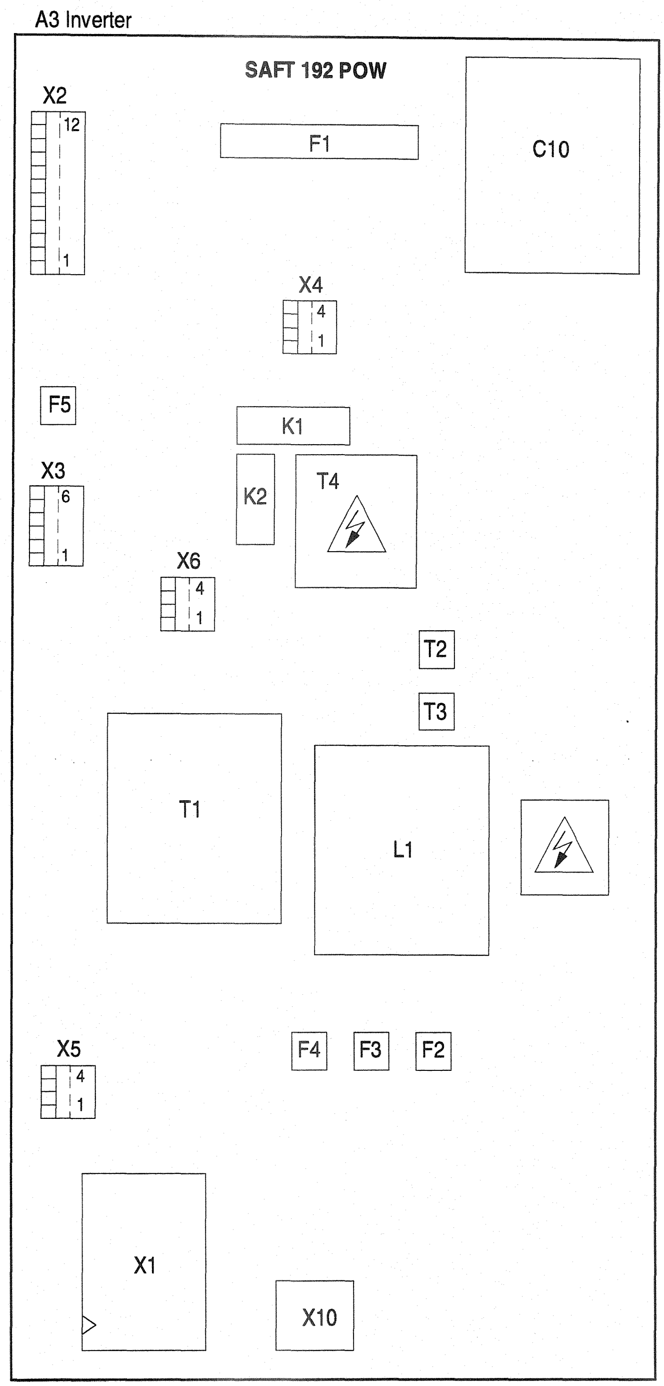


Figure 2-16 GTR Power Supply Card

The 220V AC is rectified and used to produce the control voltage until the DC bus is charged. The supply is then derived from the DC bus. The Power Supply produces DC voltages of +14V DC, + 24V DC and + 5V DC. In addition to DC voltages, the Power Supply produces a 42V, 80 kHz square wave which is used in the Pulse Amplifier Cards. The Power Supply also provides feedback information on the status of the DC bus to the Control Card.

GTO Chopper Control Card SAFT xxx CHC

The Chopper Control Card Figure 2-17 controls the gating of the chopper GTO V17 in GTO Inverter Units. Energy from the commutation of the GTO's in the main inverter bridge which appears across the clamping capacitor C9 is fed back to the DC bus through GTO V17. The amount of energy transferred is determined by the duty cycle of V17.

Control logic on the Chopper Control Card receives a clamping capacitor voltage reference signal from the Control Card which has been derived from the Matching Card. This value is compared to the actual measured value of the capacitor voltage by means of DC bus voltage and GTO terminal voltage feedbacks. The error between the reference and feedback determine the duty cycle of the chopper GTO and is used to produce a gate signal for the GTO which is then amplified.

The amplifier circuitry is very similar to that used in the GTO Pulse Amplifier cards. In addition to the gate signal, the amplifier circuit provides for monitoring of the power supply and protection of the amplifier circuit. In the event of a shorted device, fuse F1 will open, protecting the amplifier circuit.

IMPORTANT: *no recommended adjustments, measurements or switches on this board.*

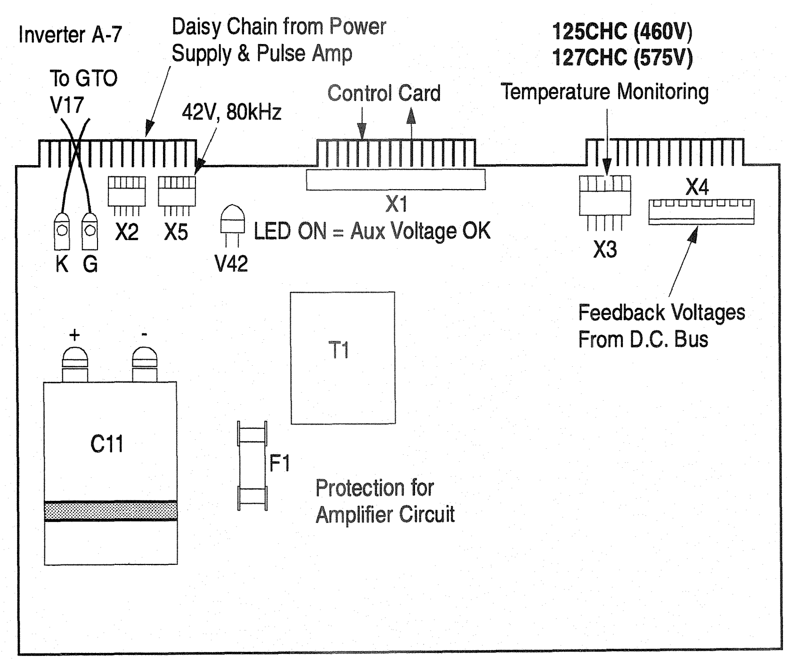


Figure 2-17 GTO Chopper Control Card

GTO Power Supply Card SAFT xxx POW

The Power Supply Figure 2-18 is used to supply voltages to both the Control Card and the Pulse Amplifier Cards in the GTO-INU. The DC voltages used for control come from the Auxiliary Power Card which derives its power from the DC bus. DC voltages produced are +14V DC and +5V DC. In addition to DC voltages, the Power Supply produces a 42V, 80 kHz square wave which is used in the Pulse Amplifier cards and by the Auxiliary Power Card. The Power Supply also provides feedback information on the status of the DC bus to the Control Card. Jumpers S1 and S2 can be used to simulate proper voltages on the card when DC bus is not charged.

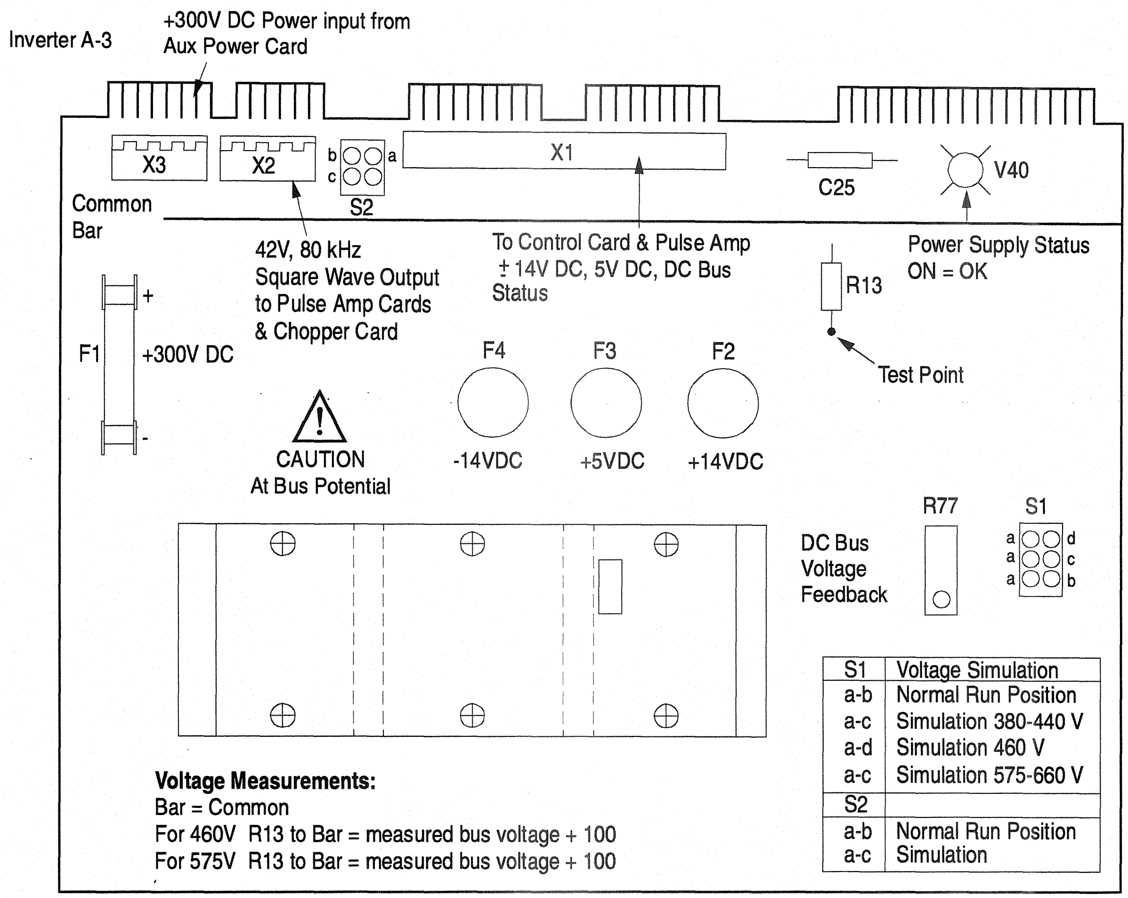


Figure 2-18 GTO Power Supply Card

Table 2-6 shows the GTO Power Supply Card identification numbers by voltage and KVA.

Table 2-6 Identification Numbers

Voltage	kVA	Code
460	180-460	110-POW
460	580-730	111-POW
575	140-540	112-POW
575	700-870	113-POW

Auxiliary Power Card SAFT 190 APC

The Auxiliary Power Card Figure 2-19 is used to provide +300V DC as normally derived directly from the DC bus. Upon initial power up, or if the DC bus voltage drops momentarily, a secondary source of power provided to the Auxiliary Power Supply Card in the form of 220V AC from the INU control transformer is rectified to +300V DC and supplied to the Power Supply Card. A 20V AC input from the INU control transformer is rectified to produce auxiliary +24V DC. The 42V, 80 kHz square wave from the Power Supply is used to produce an auxiliary + 14V DC.

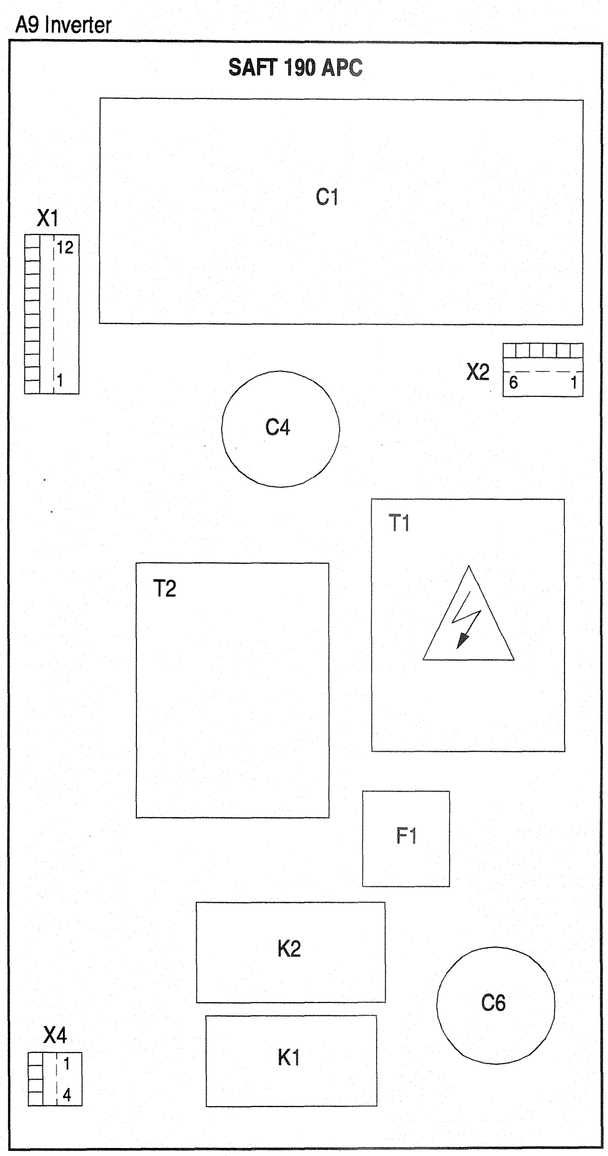


Figure 2-19 Auxiliary Power Card

Input/Output Connection Card SAFT 188 IOC

The Input Output Connection Card Figure 2-20 interfaces the INU Control Card to various external devices. The board must be used with the 174 TBC Terminal Block Card through connector X1. Control Panel CP1 connects to X5 and provides local control and monitoring of the drive. Optional Analog I/O Cards can be connected to X4.

The IOC Card has exclusive use of Drive Channel 1. On start up, the IOC processor checks for transmissions from the drive and adjusts its baud rate accordingly. If no messages are received from the drive, CP1 displays "SAFP11".

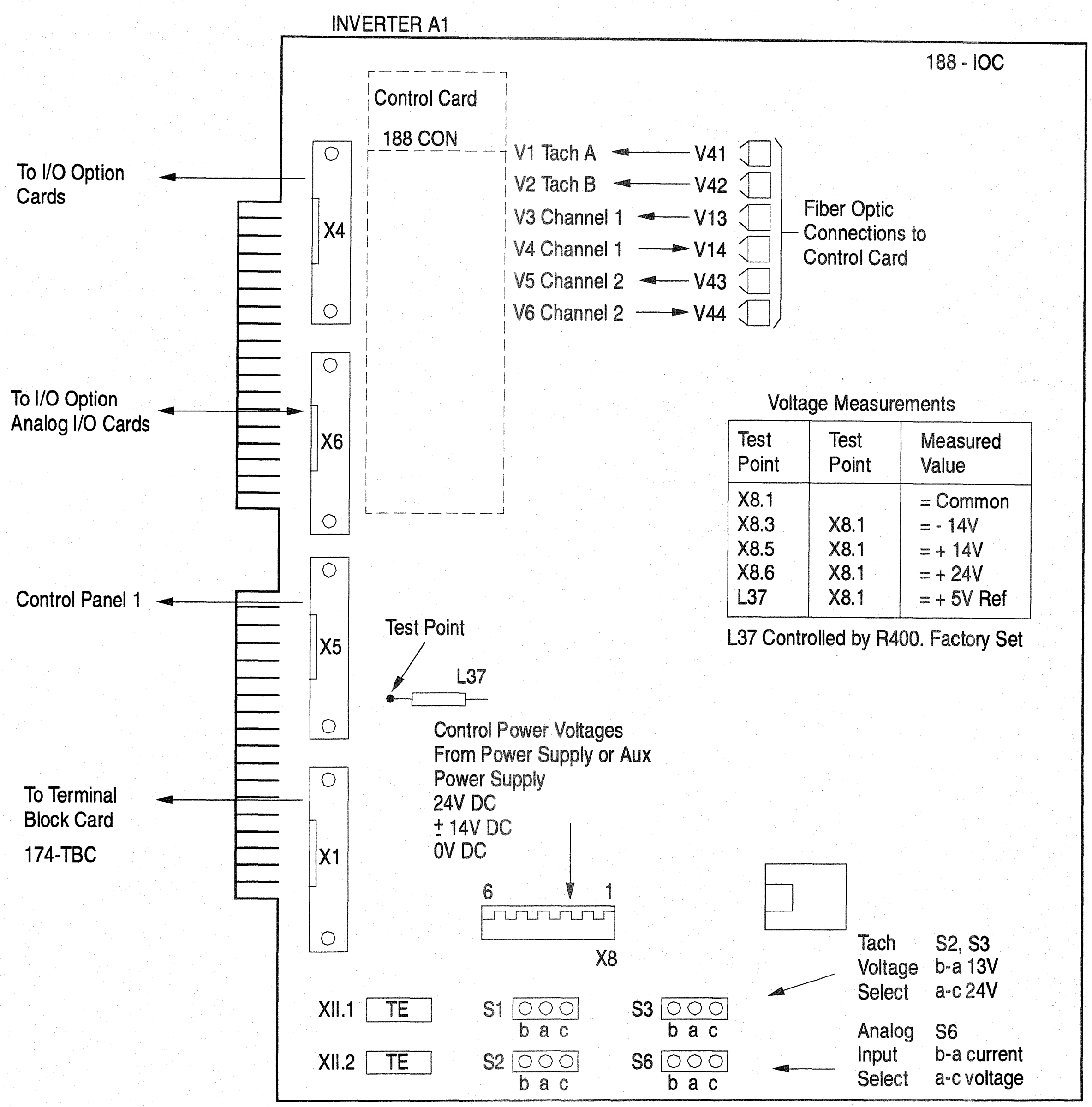


Figure 2-20 Input/Output Connection Card

The IOC also identifies option cards that are connected to it and optimally initializes a buffer for inputs to the drive. The buffer consists of 10 codes of messages to be sent to the drive. Each message takes about 20 ms at 4800 baud or 10ms at 9600 baud. With no option cards, the buffer is initialized for the following messages to be sent each scan:

- 4 analog input 0 messages are sent to parameter 246.
- One digital input message is sent to parameter 245.
- 4 more analog input 0 messages are sent to parameter 245.
- CP1 push-button data is sent to parameter 19.

Analog and digital outputs from the drive to the IOC Card are set up in the drives recurring output transmission table (parameters TEE 114 to TEE 129).

The board receives 24V DC and +14 V DC. It produces its own 5 VDC control power.

Terminal Block Card SAFT 174 TBC

The Terminal Block Card serves as a connection point for many standard features of the 188 Input/Output Connection Card (IOC). See Figure 2-21 for the connection diagram of both cards.

The TBC is connected to the IOC via a 40 conductor ribbon cable at connector XI.

Terminal Block X3 provides connection for the following:

- 8 digital inputs.
- 4 digital outputs.
- 1 analog input.
- 2 analog outputs.
- 12/24 V DC power for tach.
- 2 tach input channels.
- Current loop input for serial drive channel 2.
- Current loop output from serial drive channel 2.

Terminal Block X4 provides connection for up to 2 isolated analog inputs and 2 isolated analog outputs. The TBC passes signals through connector X2 via 10 conductor ribbon cable and connects to the option board.

Connector K5 provides for a standard connection to a Remote Control Panel or the DMS Current loop interface. This connection shares Drive channel 2 with the serial I/O on Terminal Block X3.

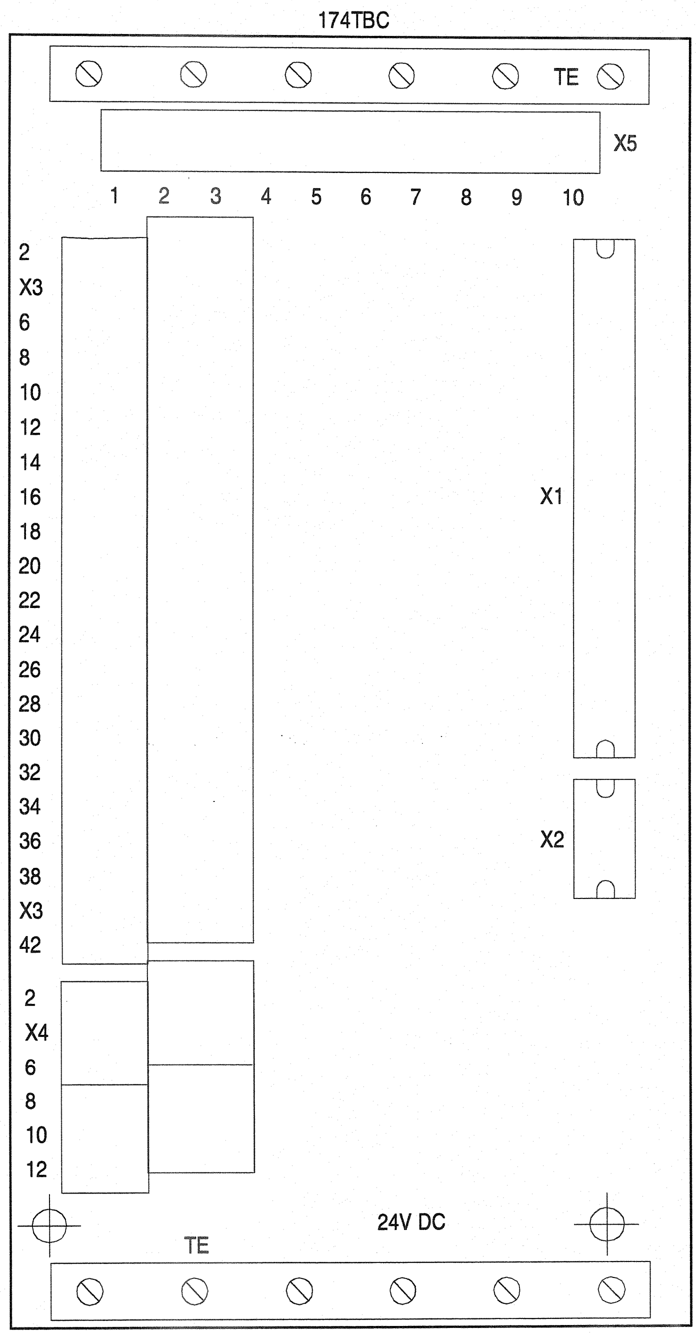


Figure 2-21 Terminal Block Card

There are no voltage adjustments on the TBC Board. The + 5V DC, +24V/13V and +24V DC enter the TBC via X1. Regulated 12V DC is supplied to various control board circuits as required.

CBU Supervision Card SAFT 132 CBS

On Capacitor Bank Units of 290 kVA and larger, the voltage across each individual segment of the capacitor bark is monitored for over voltage conditions. Monitoring is performed using the CBU Supervision Card (Figure 3-37). LEDs on the card indicate the condition of the voltage level across each capacitor segment. Either 3 (460V) or 4 (575V) LEDs will be used depending on whether 3 or 4 capacitor bank segments are connected in series. Under normal operation, there should be one LED lit for each capacitor bank segment. If the voltage on a particular capacitor bank segment drops below 130V or exceeds 400V, current flow through pins on connector X6 is stopped and a relay circuit in the CTU is alerted to the fault, tripping the Drive. Since these segments should be balanced, a preventative maintenance routine is to periodically measure the segments (X1..X2,X2..X3,X3..X4,X4..X5) and if an unbalance is detected which is not severe enough to trip the Drive, plan a controlled shutdown to check & replace failed capacitors and/or capacitor fuses.

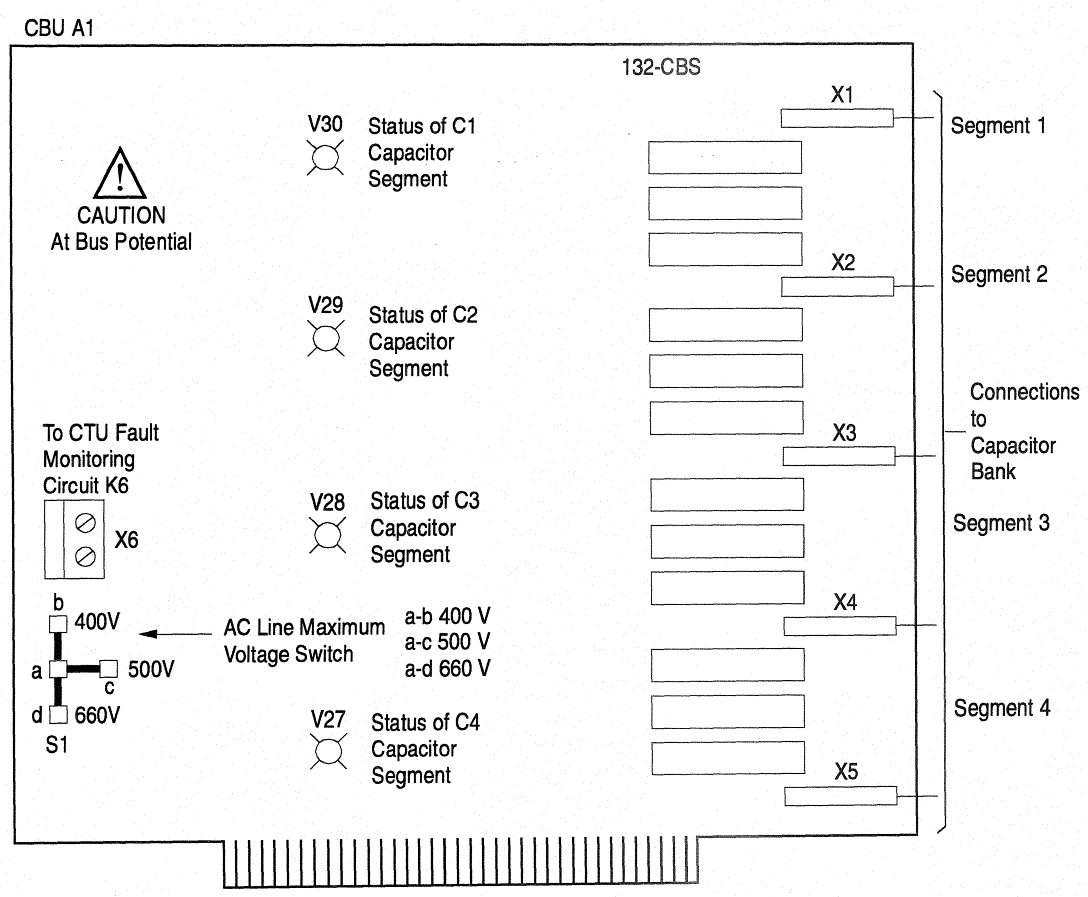


Figure 2-22 CBU Supervision Card

Analog Input Card SAFT 162 INP

The Analog Input Isolation Card SAFT 162 INP Figure 2-23 provides one additional analog input channel which is galvanically isolated (10 bit). Permissible signals are -10 to + 10V DC; 0 to 10V DC; or 0 to 20mA. Selectable via jumpers. NOTE: 4 to 20mA, 20 to 4mA, and other variations are scalable in software.

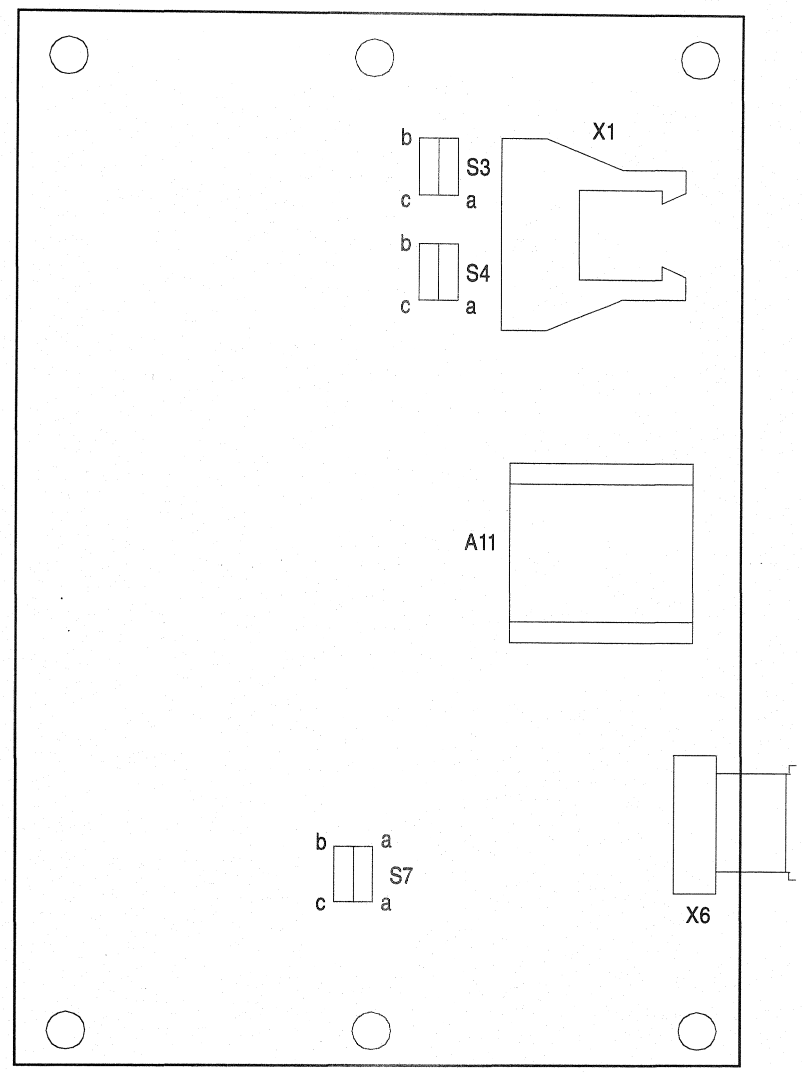


Figure 2-23 SAFT 162 Analog Input Card

Table 2-7 shows the Analog Input selection.

Table 2-7 Analog Input Current or Voltage Selection

Input 1	S3,S4	S7
0-20 mA 4-20 mA	a-c	a-c
-10- +10 V	a-b	a-b
0- +10 V	a-b	a-c

Analog I/O Card SAFT 164 AIO

The Analog Input & Output Card SAFT 164 AIO Figure 2-24 provides two additional analog input channels (10 bit) and two additional analog output signals (12 bit). Permissible signals are -10 to + 10V DC; 0 to 10V DC; or 0 to 20mA, selectable via jumpers. All channels are galvanically isolated.

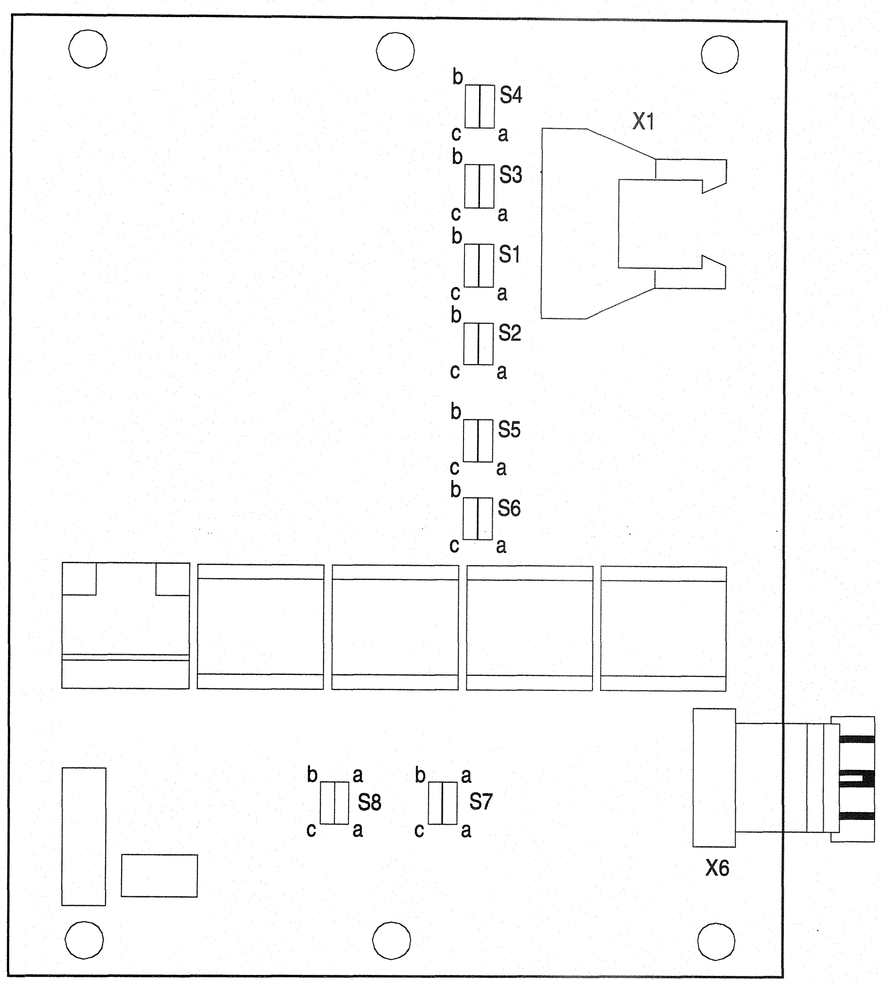


Figure 2-24 SAFT 164 Analog I/O Card

NOTE: 4 to 20mA, 20 to 4mA, and other variations are scalable in software. With this option, there will be a total of three independent analog inputs and four independent analog outputs.

Table 2-8 shows the Analog Input selection.

Table 2-8 Analog Input Current or Voltage Selection

Input 1	**S3,S4**	**S7**
0-20 mA 4-20 mA	a-c	a-c
-10- +10 V	a-b	a-b
0- +10 V	a-b	a-c
Input 2	**S5,S6**	**S8**
0-20 mA 4-20 mA	a-c	a-c
-10- +10 V	a-b	a-b
0- +10 V	a-b	a-c

Table 2-9 shows the Analog Output selection.

Table 2-9 Analog Output Current or Voltage Selection

Output 3	**S1**
0-20 mA 4-20 mA	a-c
-10- +10 V 0- +10 V	a-b
Output 4	**S2**
0-20 mA 4-20 mA	a-c
-10- +10 V 0- +10 V	a-b

Analog I/O Card SAFT 186 AIO

The Analog Input & Output Card SAFT 186 AIO Figure 2-25 provides one additional analog input channel (12 bit) and two additional analog output signals (12 bit). Permissible signals are -10 to + 10V DC; 0 to 10V DC; or 0 to 20mA, selectable via jumpers. All channels are galvanically isolated.

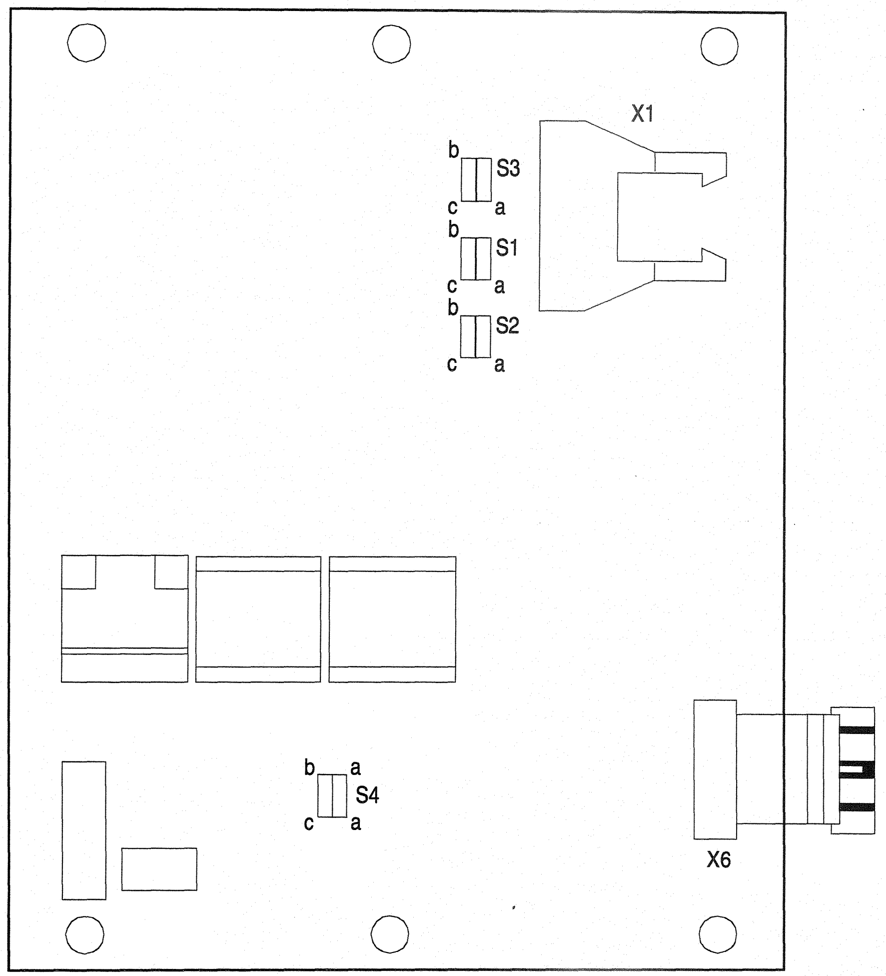


Figure 2-25 SAFT 186 Analog I/O Card

NOTE: 4 to 20mA, 20 to 4mA, and other variations are scalable in software. With this option, there will be a total of two independent analog inputs and four independent analog outputs.

Table 2-10 shows the Analog Input selection.

Table 2-10 Analog Input Current or Voltage Selection

Input 1	**S3**	**S4**
0-20 mA 4-20 mA	a-c	a-c
-10- +10 V	a-b	a-b
0- +10 V	a-b	a-c

Table 2-8 shows the Analog Input selection.

Table 2-11 Analog Input Current or Voltage Selection

Output 3	**S1**
0-20 mA 4-20 mA	a-c
-10- +10 V 0- +10 V	a-b
Output 4	**S2**
0-20 mA 4-20 mA	a-c
-10- +10 V 0- +10 V	a-b

Relay Output Card SAFT 175 RDO

The Relay Output Card SAFT 175 RDO Figure 2-26 provides four programmable independent relay contact outputs in addition to four 24V DC digital outputs. Contacts are selectable NO or NC. Contact rating is 250V AC, 5 Amperes, continuous 10 Amperes inrush. 200VA is available from the Drive. Refer to Chapter 3 for wiring diagram.

A11
Relay Output Card
SAFT 175 RDO

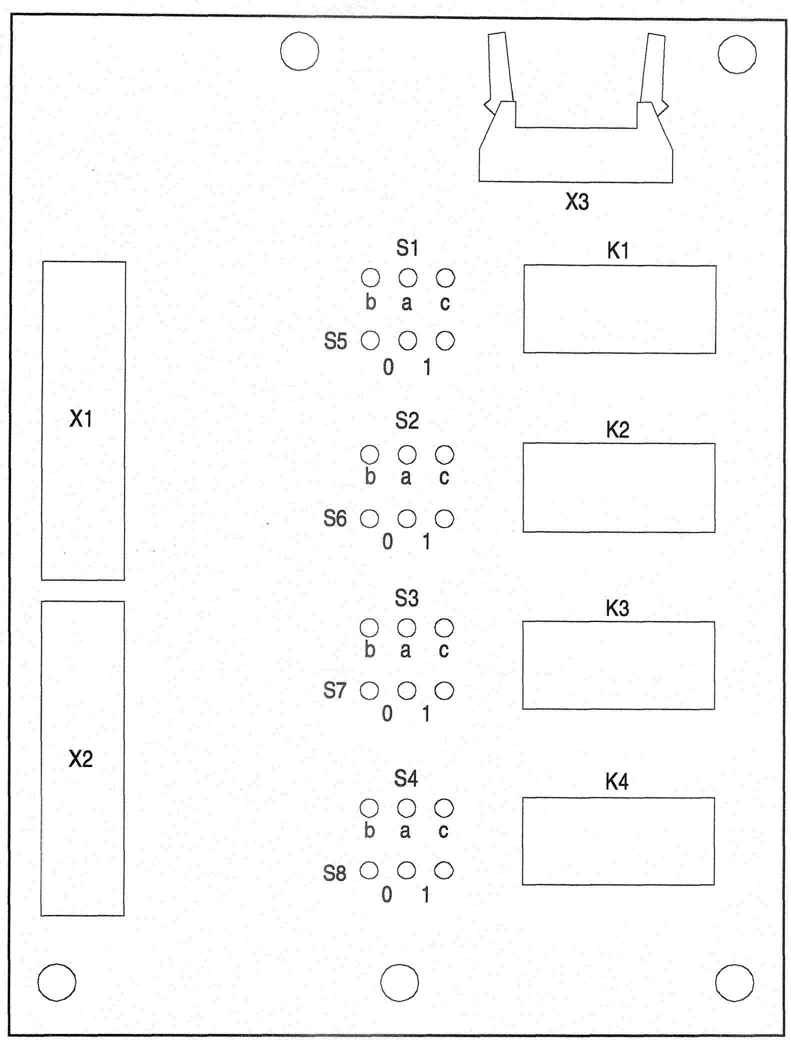
Selection of Relay Contacts

Switch	a-b	a-c
S1 DOUT 4	X	
S2 DOUT 5	X	
S3 DOUT 6	X	
S4 DOUT 7	X	

Switches S5 -S8

State	Description
0	No transient suppression
1	Transient suppression

Note: Factory default setting show with an X, and no transient suppression.



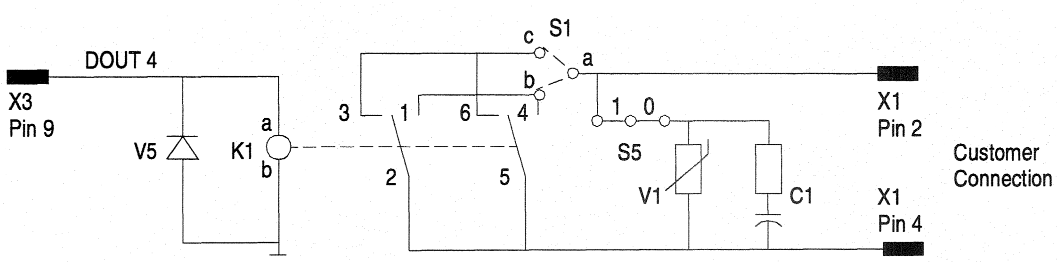


Figure 2-26 Relay Output Card and Typical Board Schematic.

Tach Serial Interface SAFT 189 TSI

The Tach Serial Interface Card SAFT 189 TSI Figure 2-27 is a simple interface board that can be used with Vector or Scalar controlled drives which are operated remotely by a Digital Reference Controller (DRC).

This board provides the following interfaces:

- Full duplex serial communication to Optical Drive Channel I from current loop connection at X2. (Usually System Controller)
- Full duplex serial communication to Optical Drive Channel 2 from current loop connection at X1. (usually DMS)
- Auxiliary full duplex serial communication sharing Optical Drive Channel 2 from current loop connection at X6. CP5 (CP2)
- 13/24V DC Power for Pulse Tachometer and conversion of 2 tach channels to Optical signal at X3.
- Power to the Coast Stop Relay.

Connector X4 provides a termination point for control wiring. Pin 1 is connected to pin 2 and pin 3 is connected to pin 4.

The board receives voltages of 24V DC and +13V DC via connector X8 and produces a regulated 5V DC output.

There are no voltage adjustments or jumpers on the board. Sourcing of the current loop and voltage level for the Tach signals are controlled by the wiring of the connectors.

CAUTION: Pins 7 and 8 of connector X3 must be used for 13V DC Tach connection to ensure reliable operation of speed controlled drive.

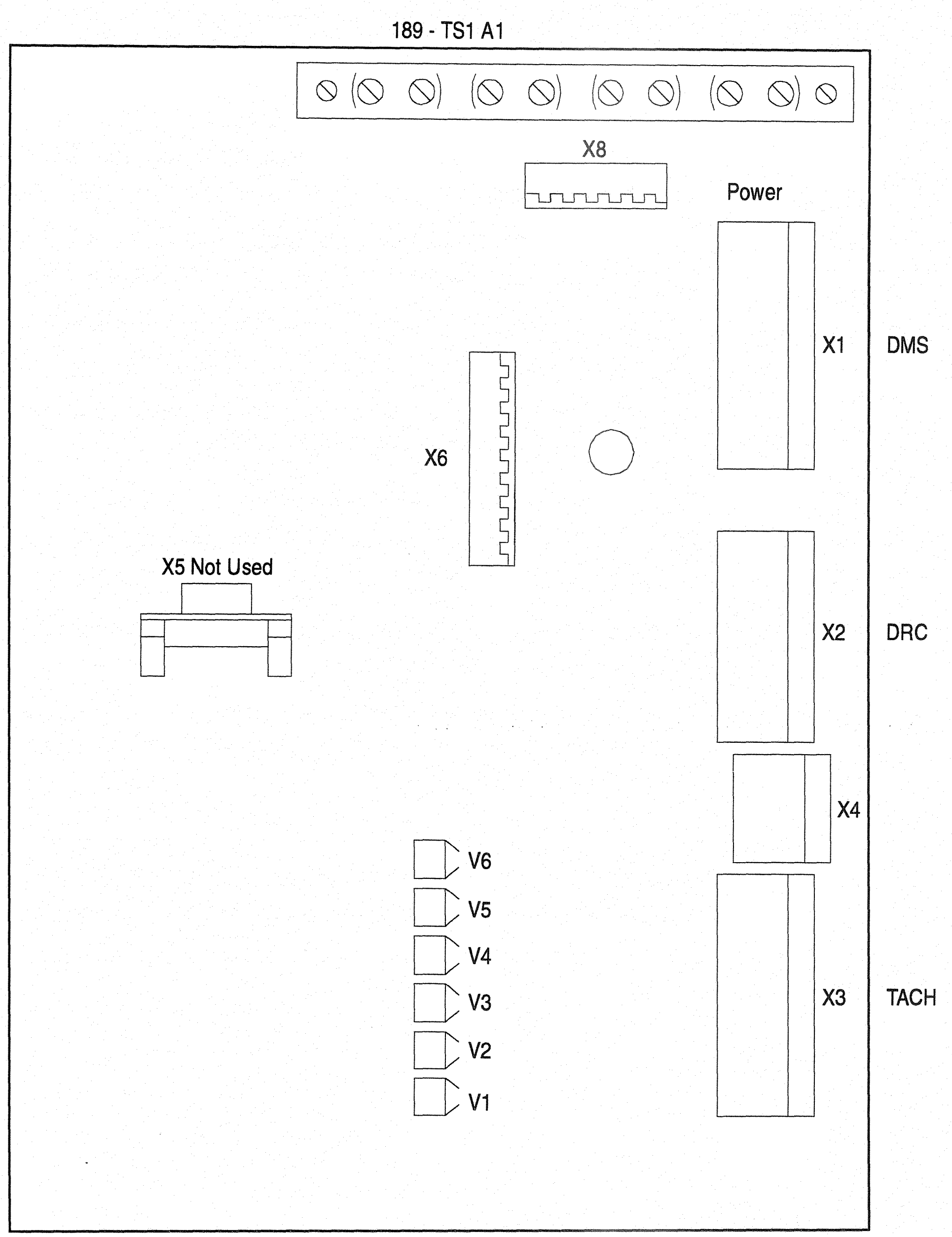


Figure 2-27 Tach Serial Interface Card

TBX Interface

The TBX Interface Board is a direct replacement for the Tach Serial Interface Board used with the SAMI STAR AC Drives. The TBX Board includes a Host/Plug Interface which is used in place of the SAMI Protocol Drive Channel 2, 20 mA Current loop interface. This enables the drive to connect to remote I/O communication networks. Other TBX Interface enhancements to the TSI Interface include:

- Drive parameter table image
- Configurable parameter table manager
- Four 120V AC digital inputs
- Four 120V AC digital outputs

For Communication and Remote I/O options consult ABB Industrial Systems Inc.

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Chapter 3 – Installation Instructions

Pre-Installation

This chapter explains how to install the SAMI STAR and connect all power, motor, and control wiring. It also describes the initial inspection procedures.

WARNING! The National Electrical Code (NEC) or local codes outline provisions for safely installing electrical equipment. Installation MUST comply with specifications regarding wire type, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

Unpacking & Inspection - After unpacking the material, check the item(s) received against the bill of lading to assure that the nameplate description of each item agrees with the material ordered. Inspect the SAMI STAR, AC Drive Controller and the other equipment for physical damage, as stated in the ABB Drives Inc., Terms and Conditions of Sale.

IMPORTANT: *All claims for breakage and damage whether concealed or obvious must be made to the carrier by the Customer as soon as possible after receipt of the shipment. ABB Drives Inc. will be glad to render the Customer reasonable assistance in the securing of adjustment for such damage claims.*

Remove all packing material, wedges, or braces from within the Drive Controller. Operate the contactors and relays manually to assure that they operate freely. If any part of the equipment will not be installed when it is unpacked, it should be stored in a clean, dry place. The storage temperature must be between -40C (-40F) and 70C (158F) with a maximum humidity of 90%, non-condensing, to guard against damage to temperature sensitive components in the controller.

Transportation & Handling

The SAMI STAR AC Drive must be transported on a pallet or via use of the lifting beam supplied as part of all 90 inch high cabinets.

Round rollers can be used to assist in moving the Drive to the installation site. Once at the final site, the pipe rolling technique can be used to place the cabinet in the desired position.

WARNING! Care must be exercised when using either a forklift or the pipe rolling technique for positioning purposes to ensure that the equipment is not scratched, dented or damaged in any manner. Always exercise care to stabilize the Drive during handling to guard against tipping and injury to personnel.

Installation Site

When selecting the installation site, the following conditions should be considered:

1. The operating ambient temperature must be between 0C (32F) and 40C (104F) for NEMA Type 1 enclosures. For NEMA Type 12 enclosures, the operating ambient temperature must be between 0C (32F) and 50C (122F).
2. The relative humidity must not exceed 95% non-condensing. Excessive humidity can cause corrosion or excessive dirt build-up leading to possible electrical problems.
3. The equipment must be kept clean. Dust build-up inside the enclosure inhibits proper cooling and decreases the system reliability. If the environment is excessively industry, it requires an optional fan & filter kit modification. Contact ABB Drives Inc. for more details.
4. Only persons familiar with the function of the Drive should have access to the equipment.
5. The losses in the Drive produce a definite heat dissipation depending on unit size that tends to warm the air in the room. Attention must be given to the room ventilation and cooling requirements to ensure the proper environmental conditions are met.
6. Operational altitude is 3300 feet (1000m) maximum without derating.
7. The area of the Drive should be free of radio frequency interference such as encountered with some welding units. This could damage the integrated circuits and cause malfunctions.

CAUTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as, under sizing the motor, incorrect or inadequate AC supply, or ambient temperatures above or below specified temperature range may result in malfunction of the Drive.

Dimensions

Table 3-1 lists the SAMI STAR weights in pounds and dimensions in inches and mm.

Table 3-1 Weights and Dimensions of SAMI STAR Units

SAMI	WEIGHT lbs	HEIGHT		WIDTH		DEPTH	
		inch	mm	inch	mm	inch	mm
VOLTAGE 460							
30F460	485	92	2340	26	650	26	650
50F460	485	92	2340	26	650	26	650
75F460	485	92	2340	26	650	26	650
100F460	530	92	2340	26	650	26	650
115F460	530	92	2340	26	650	26	650
150F460	795	92	2340	36	900	26	650
180F460	795	92	2340	36	900	26	650
230F460	1035	99	2517	60	1500	26	650
290F460	1035	99	2517	60	1500	26	650
370F460	1545	99	2517	73	1845	26	650
460F460	1545	99	2517	73	1845	26	650
580F460	2070	99	2517	103	2600	26	650
730F460	2070	99	2517	103	2600	26	650
VOLTAGE 575							
110F575	795	92	2340	36	900	26	650
140F575	795	92	2340	36	900	26	650
210F575	1100	99	2517	60	1500	26	650
280F575	1410	99	2517	73	1845	26	650
340F575	1410	99	2517	73	1845	26	650
440F575	1630	99	2517	73	1845	26	650
540F575	1630	99	2517	73	1845	26	650
700F575	2180	99	2517	103	2600	26	650
870 F575	2180	99	2517	103	2600	26	650

Wiring

Grounding Practices

Proper grounding of the SAMI STAR Drive system is essential since it:

- Protects personnel from dangers resulting from insulation failure.
- Protects equipment from damage due to lightning discharge, power surges and arcing faults to ground.
- Ensures proper operation of electrical equipment in the system.
- Ensures proper operation of protective devices under ground fault conditions.

The SAMI STAR is equipped with both a PE bus and a DC bus in order to provide proper grounding and to ensure proper operation of the equipment. Each bus in a tinned copper bar located near the base of the enclosure and runs the length of the enclosure. Specifics of each bus are:

PE - Ground Bus - This is the safety ground required by code. The Ground Bus can be connected to adjacent building steel (girder, joist) or a floor ground loop. Multiple connections are allowed as long as they do not permit an excess flow of current.

TE - Signal Common Bus - This is a separate bus used as a common tie point for all signal/communication shields. It is kept separate to isolate it from the voltage changes on the PE bus due to normal or objectionable current flow. This bus must still remain at or near 0 volts with respect to the PE bus. The resistance between the PE and TE bus should be less than 1 Ohm through the building ground system.

The TE bus should be connected to PE in the System Controller cabinet. In some single drive applications having minimal communication requirements, reliable performance can be achieved by simply connecting the TE bus to the PE ground bus inside the enclosure.

IMPORTANT: *Grounding must be in accordance with the National Electrical Code (NEC) and local codes. See NEC article 250 for grounding information and conductor sizing. See NEC article 800 for information on communication circuit grounding.*

Each power feeder from the substation transformer to the Drive must be provided with properly sized ground cables. Simply utilizing the conduit or cable armor as a ground in not adequate. The conduit or cable armor and ground wires should be bonded to ground at both ends. Each transformer enclosure and/or frame must be bonded to ground at a minimum of two locations.

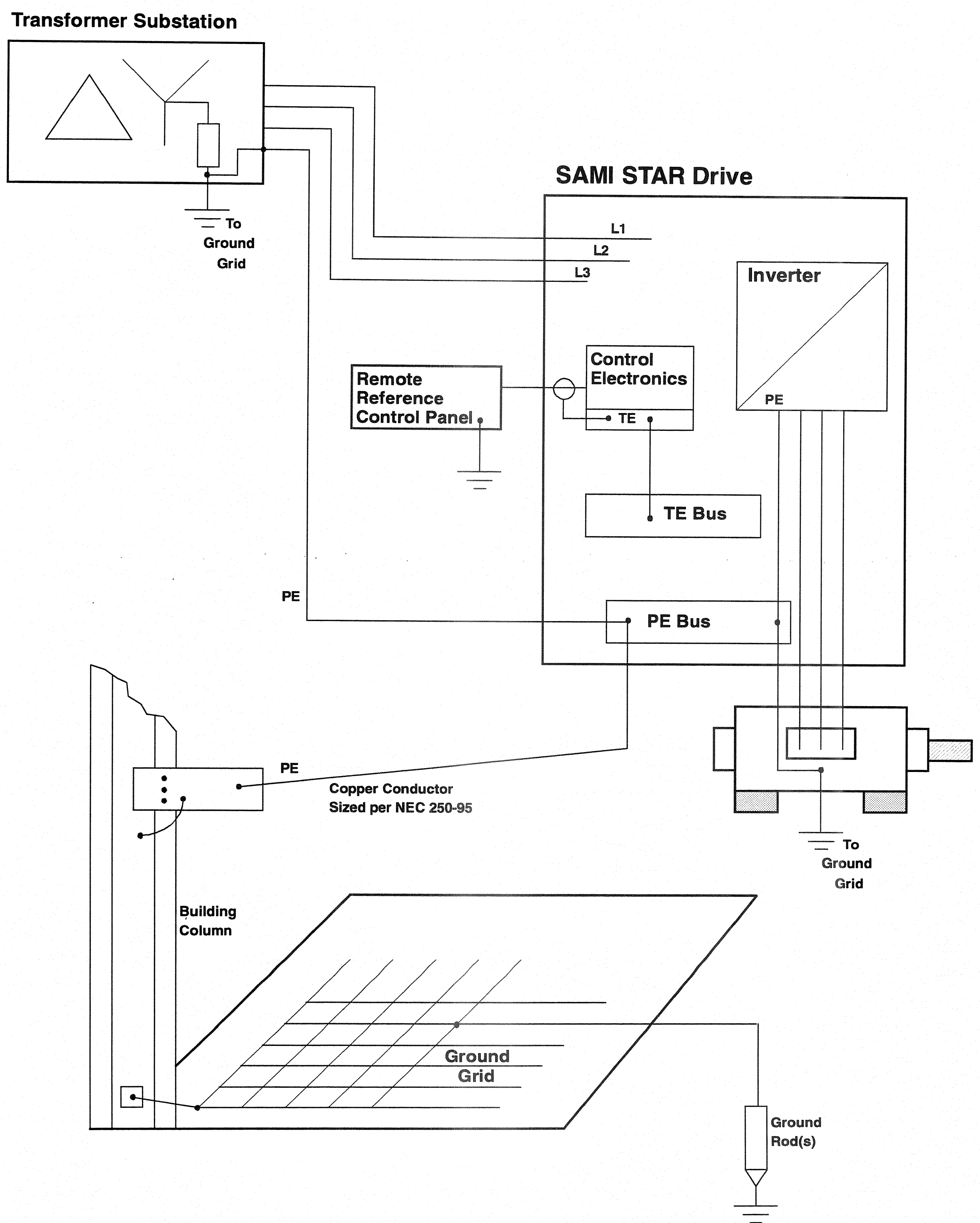


Figure 3-1 System Grounding Practices

Each AC motor frame must be bonded to grounded building steel within 20 feet of its location and tied to the Drives PE via ground wires within the power cables and/or conduit. The conduit or cable armor should be bonded to ground at both ends.

The Remote Operator Control Panel (if used) must be bonded to grounded building steel within 30 feet of its location and tied to the Drive PE via ground wires within the cable conduit and/or cable tray. Bond conduit or cable armor at both ends.

Tachometer connections, if required, must be routed in grounded steel conduit. The conduit must be grounded at both ends. Connect the cable shield to the Drive TE Signal bus at the Drive end only.

Generally, all shields connected to the TE bus should be connected at the Drive end only to prevent current flow.

Refer to Figure 3-1 for a grounding system example or for more information, see the Schematic Diagram that accompanies the drive for each particular application.

Refer to the Instruction Manual for each auxiliary device connected to the Drive for any special grounding recommendations.

WARNING! Upon completion of the control and power wiring, inspect the drive for pieces of wire that may have fallen into the bottom of the unit. Use a vacuum to pick up the pieces and clean the drive. If any material has fallen into the INU, remove the material before applying power.

Power Connections - The Drive requires a three-phase supply and an equipment grounding conductor to earth ground. A neutral conductor of the three-phase supply is not necessary and is usually not routed to the Drive. Three-phase wiring and a grounding conductor connects the Drive to the motor. Cable and wiring recommendations are specified in Table 3-2.

The wire sizes must be selected individually, observing all applicable safety and NEC regulations. The minimum permissible wire size does not necessarily result in the best operating economy. The minimum recommended size for the wires between the Drive and the motor is the same as that used if a line voltage to the motor was used. The distance between the Drive and motor may affect the size of the conductors used. Consult the wiring diagrams and appropriate NEC regulations to determine correct power wiring.

IMPORTANT: *The National Electrical Code (NEC) requires that branch circuit protection of the AC line input power to the Drive be provided by circuit breaker or fusible disconnect switch.*

Wire Size

Table 3-2 lists the cable and wiring requirements for the SAMI STAR.

Table 3-2 Cable And Wiring Recommendation

Category	Wiring Class	Signal Examples	Signal Examples	Cable Type
POWER	1	AC Power (>600 VAC)	2.3KV 3 Phase AC Lines	Per NEC & Local Codes
	2	AC Power (< 600 VAC)	480V 3 Phase AC Lines	
	2	DC Power	DC Motor Armature	
	2	DC Power	DC Motor Armature	
CONTROL	5	115 VAC Logic	Relay Logic, inter-locks, MP I\O	Per NEC & Local Code
		115 VAC Power	Power Supplies, Instruments	
	6	24 VDC Logic	Remote I\O, MP I\O	
SIGNAL	7	Analog Signals (<300Ft) DC Power Supply	References, Feedbacks, RTDs, Transducers, Meters, 5 to 48 VDC PWR Supplies	Belden 9318, 9341, 9365, 9552
		Digital (Low Speed, Low Power)	24 VDC Drive, TTL Level	
		Analog Signals (< 600 V)	SHUNTS	Belden 9341
	8	Digital (High Speed)	Tach Feedback,. Encoder/Counter I\O Pulse	Belden 9730
COMMUNICA-TION	9	RS-232	Event Printer	Belden 8641, 9729
		Master Field Bus RS-484 (<100 Ft)	SDB DCU to DCU, SBD Remote I\O to Remote I\O	Belden 9728
			SDB Modem & PWR Supply To DCU or Remote I\O	Belden 9728
		MB 200 (RS-422)	MP to MP MP to MV	Belden 8641, 9729

Category	Wiring Class	Signal Examples	Signal Examples	Cable Type
COMMUNICA-TION	10	20 mA Loop	MP to SAMI STAR, Color Touch Screen, Printers, MV to Keyboard	Beldon 9729
	11	Twin- Ax 750 Ohm	Data Highway, DH+	Beldon 9463
	12	Master Field Bus (Coax 75 Ohm <1300Ft)	LDB Modem to Modem, R-G-B MV to Video Moni-tor	Beldon 9259 RG59/u
		Master Field Bus R-G-B Video (Coax 75 Ohm <2500Ft)	LDB Modem to Modem, R-G-B MV to Video Moni-tor	Belden 8238 RG11/u
	13	MB 300 (IEEE 802.3 <1600 Ft)	MP to MP, Mp to MV, Ethernet (Thicknet), LAN Backbone	Beldon 9880
	14	Fiber Optic Duplex, 62.5.125um <21,000 Ft Unspliced)	Point to Point Con-nection for Mfb Optic Modem, Mb 200 & MB 300 Opti-cal Modem	Beldon 225412

GENERAL NOTES

1. Steel conduit is recommended for all wiring cases, but is required for signal and communication category (Classes 7-14). Aluminum conduit requires same minimum spacing as shown for trays.All conduits should be bonded to "PE" bus or enclosure frame at both ends. All conduits connected to the cabinets should be properly sealed to minimize air or water entry into the cabinets.

2. Except where shown in diagrams shields for shielded cables must be terminated at one end only: the other end should be cut back and insulated. Shields for cables from an ABB cabinet to an external device must be terminated at the ABB cabinet end. Shields for cables from one cabinet to another must be terminated at the source end cabinet. Splicing of shielded cables, if absolutely necessary, should be done such that shield(s) remain continuous and insulated from ground. Typically master BUS 200, short distance field BUS, and AC Drive to master piece require both ends of shield(s) terminated due to high frequency filters.

Spacing Notes

1. Minimum spacing for class 1 power cables to all other class should be 3 inch conduit per 9 in tray. Minimum spacing between categories of different type circuits should be 3 inch conduit per 6 inch tray, Minimum spacing between wiring classes of different type within signal and communication categories 1 inch conduit per 3 inch tray. These are minimum spacing required for parallel runs less than 400 ft. Greater spacing should be used when possible.
2. Both outgoing and return current carrying conductors to be pulled in same conduit or laid adjacent in tray.
3. Several conductors or multiple conductor cables of same class only may be run in same conduit.
4. AC & DC Control circuits to be run in separate conduit or separated in tray. Spacing between circuits 3 inch conduit per 6 inch tray.
5. Each class of shielded cable to be run in separate steel conduit.
6. Within a cabinet, cables of different class should be separated. Different category cables should cross at 90 degrees.

Table 3-3 Cable And Accessory Recommendations

CATAGORY	CABLE DSCRIPTION	CABLE TYPE
Control	Minimum #16 AWG, 300V	
SIGNAL	2 COND 1SHD#18 AWG 600V 105°C	Belden 9341
	2 COND 1SHD #18 AWG 600V 105°C	Belden 9318
	3 COND 1SHD #18 AWG 300V 105°C	Belden 9365
	4 COND (2TP), #18 AWG 300V 105°C	Belden 9552
COMMUNICA-TION	1TP 1SHD, #24 AWG 300V	Belden 8641
	2TP 2SHD, #24 AWG 300V	Belden 9729
	3TP 3SHD, #24 AWG 300V	Belden 9730
	4TP 4SHD, #24 AWG 300V	Belden 9728
	4TP 1SHD, #24 AWG 300V	Belden 8104
	2 COND TWIN AXIAL	Belden 9463
	COAX RG 11/u 75 OHM, #18 AWG. USE WITH N-TYPE MALE CONNECTOR AMPHENOL #31-4411 AND AMPHENOL #35725-75 OHM TERMINATOR	Belden 8238
	COAX RG59/u 75 OHM. #22 AWG. USE WITH AMPHENOL #68175-1004 MALE CONNECTOR AND AMPHENOL #35725-75 OHM TERMINATOR	Belden 9259

CATAGORY	CABLE DSCRIPTION	CABLE TYPE
COMMUNICA-TION	COAX ETHERNET LAN BACKBONE, PER IEEE 802.3 TYPE 10 BASES, 50 OHM IMPEDANCE. MARKED @ 2.5m. TERMI-NATED AT EACH END WITH: INMAC #1486-1 MALE CON-NECTOR, INMAC #1006-7 BOOT AND INMAC #0824 50 OHM.	Belden 9880
	FIBER OPTIC, DUPLEX CABLE, 62.5 / 125 um DUAL WIN-DOW/DUAL JACKET, GLASS ON GLASS	Belden 225412

Control & Signal Connections - There are several basic configurations of the Drive control, depending on the type of application and what specific I/O cards are used. This section will describe the basic interconnections to external wiring for the two most common configurations. The general descriptions and diagrams are based on commonly used wiring schemes. Refer to the schematics and interconnection drawings supplied with your equipment to verify the information for your application.

CAUTION: The START/STOP control circuitry in the SAMISTAR Drive includes solid state components. If hazards due to accidental contact with rotating or sliding machine components exist, NEMA Standards require that a hard wired coast stop circuit be used with this Drive

---

Control & Signal Wires - A shielded type wire is recommended in the control circuits for protection against interference and is also required for all signal wires and 24V DC wiring. The shield should be terminated at the Drive TE bus only. DO NOT terminate both ends. The recommended conductor cross-sections should be a minimum of 18 AWG (0.05082 in). The best interference suppression is obtained with a wire having an individual shield for every pair.

IMPORTANT: *The control & signal wires should be oriented a distance of at least six (6) inches (150mm) from power cables. Additional noise suppression practices (including separate steel conduits for signal leads, etc.) are recommended. ABB recommends 24 VDC Logic wiring NOT extend 50 feet from the Drive.*

Control & Signal Interconnection - Table 3-4 provides an index to aid the installer in quickly locating the information required to connect the Drive to the proper control devices. Particular attention should be given to the signal grounds and inhibits. For more information on the specific interconnection boards see Chapter 2.

Table 3-4 External Control Connection

Software Type	Function	Card Reference	Figure Reference
Standard Scalar Software	Inhibit signals	SAFT 174 TBC	Figure 3-2
	Digital I/O	SAFT 174 TBC	Figure 3-3
	Non Isolated Analog I/O	SAFT 174 TBC	Figure 3-4
	Relay Outputs	SAFT 175 RDO	Figure 3-5
	Isolated Analog Input	SAFT 162 INP SAFT 174 TBC	Figure 3-6
	Isolated Analog I/O	SAFT 164 AIO SAFT 174 TBC	Figure 3-7
	Isolated Analog I/O	SAFT 186 AIO SAFT 174 TBC	Figure 3-8

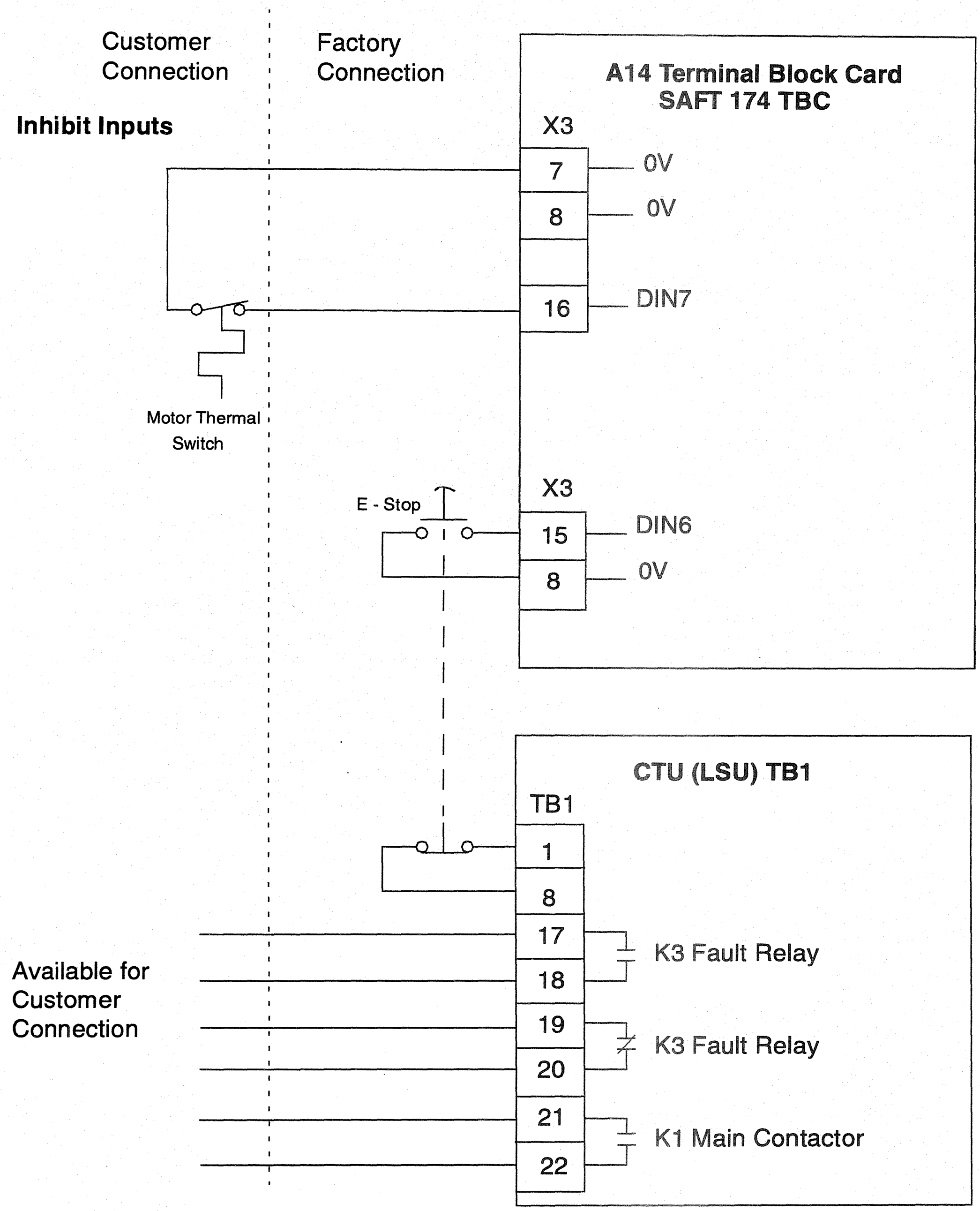


Figure 3-2 Inhibit Logic Connection

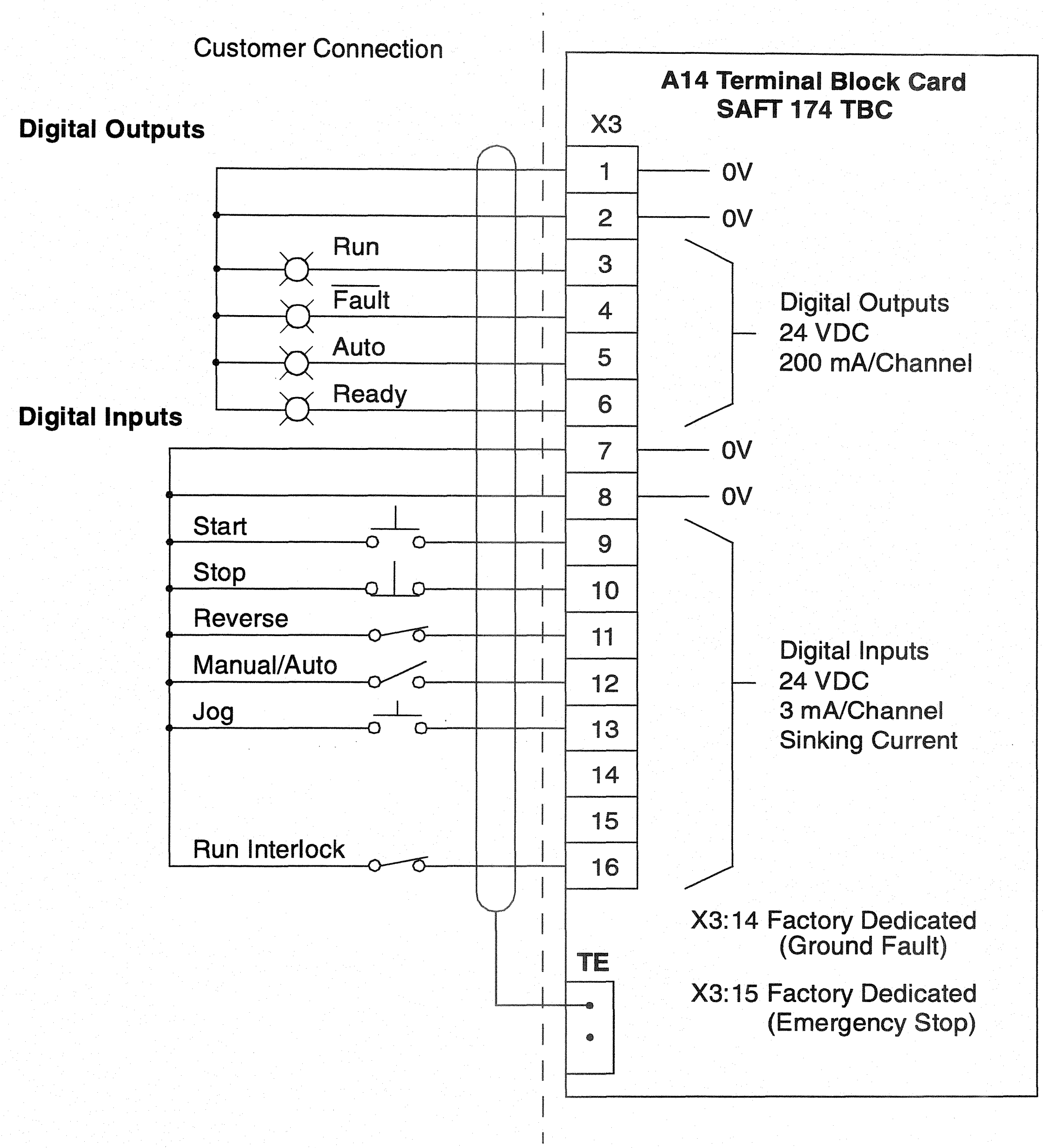


Figure 3-3   24 Volt Digital I/O Connection

SAFT 174 TBC Card

The SAFT 174 TBC has the following specifications:

• 8 Digital Inputs	24 VDC 3 mA/Cannel Sinking Current
• 4 Digital Outputs	24 VDC 200 mA/Channel
• 1 Analog Input (Speed Reference) (10 Bit Accuracy)	0-5 VDC (max 10 mA) 0-20 mA (max 4k ohm) 4-20 mA (max 4k ohm)
• 2 Analog Output (8 Bit Accuracy)	0-5 VDC (max 10 mA) 0-1 mA (max 4k ohm)

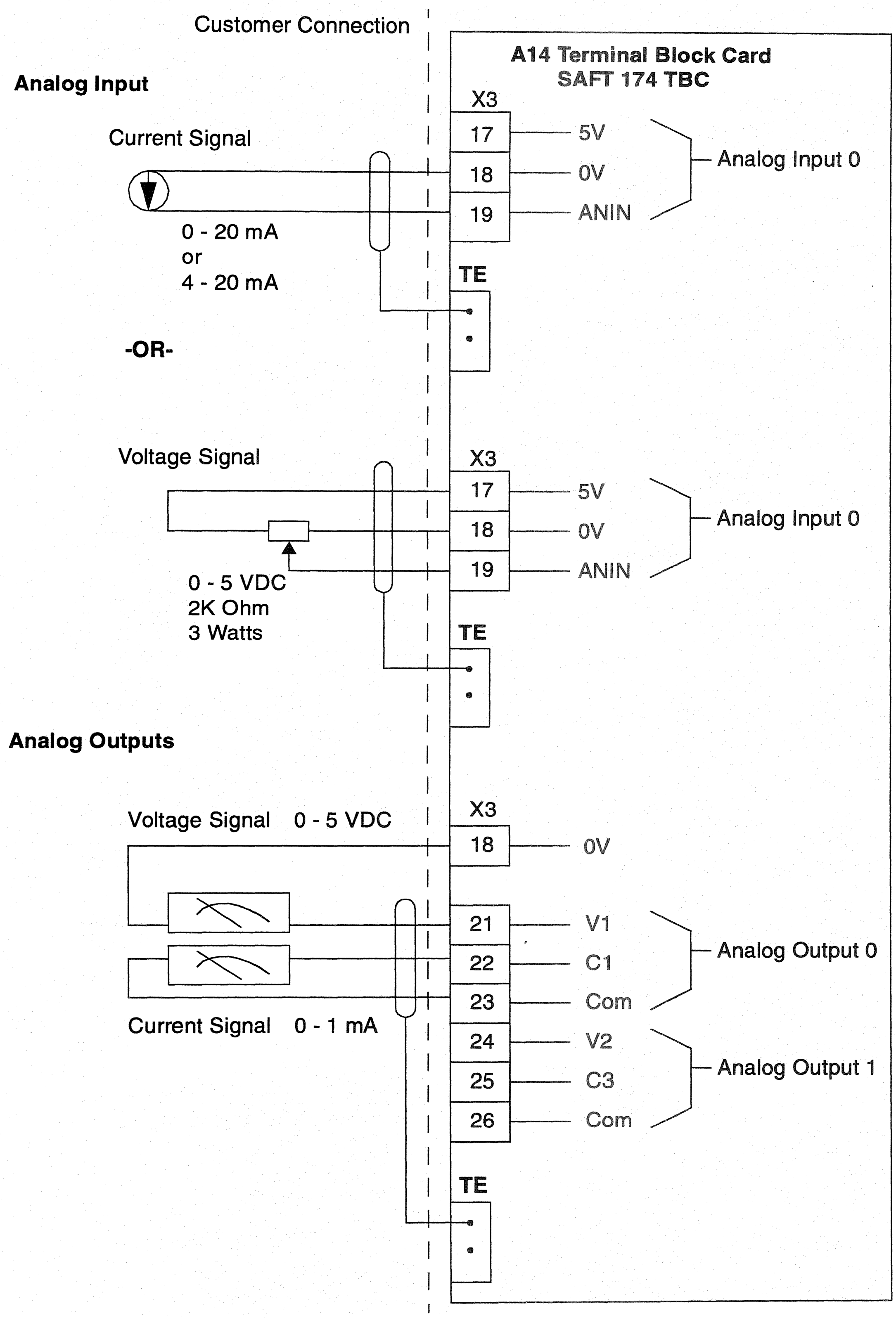


Figure 3-4 Non-isolated Analog I/O Connection

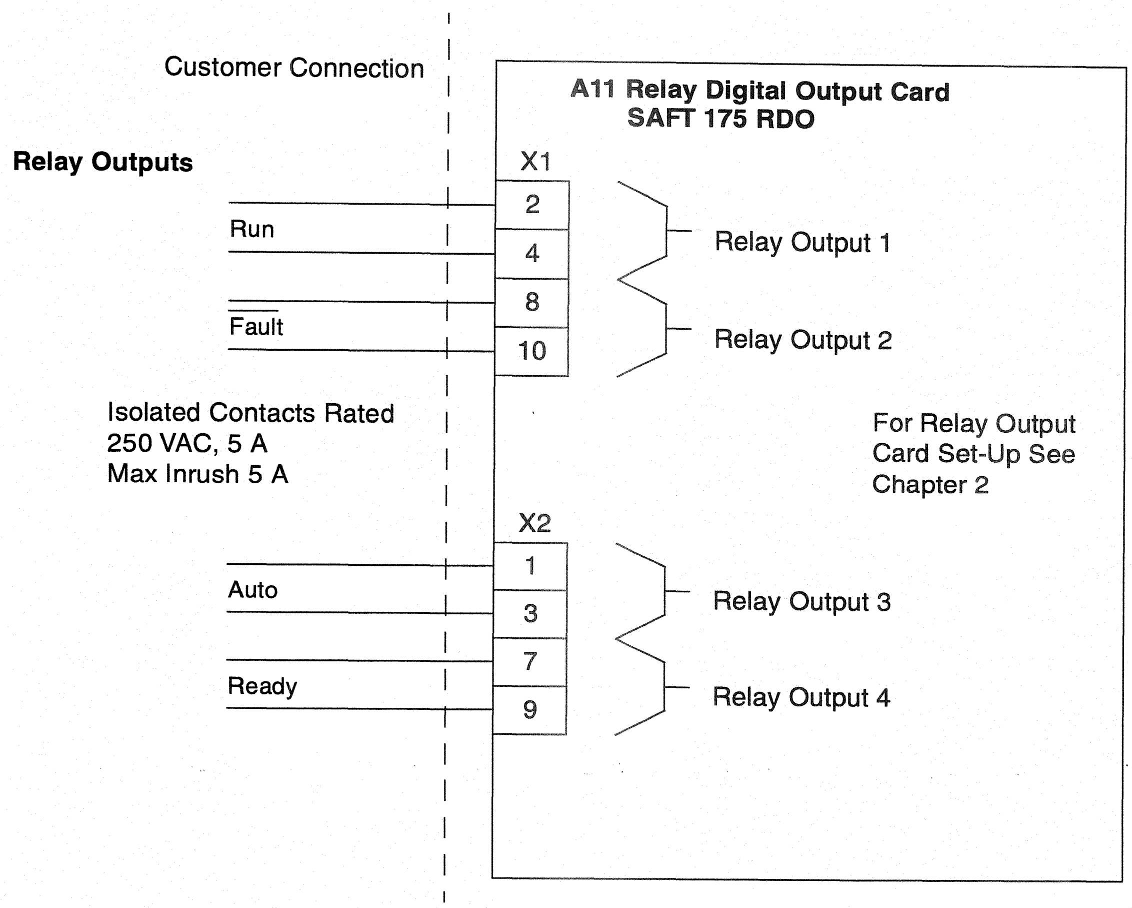


Figure 3-5 Relay Output Connection

SAFT 175 RDO Card

The SAFT 175 RDO Card has the following specifications:

- 4 Relay Outputs (Isolated Contacts): 250 VAC, 5 Amps, Max 5A inrush

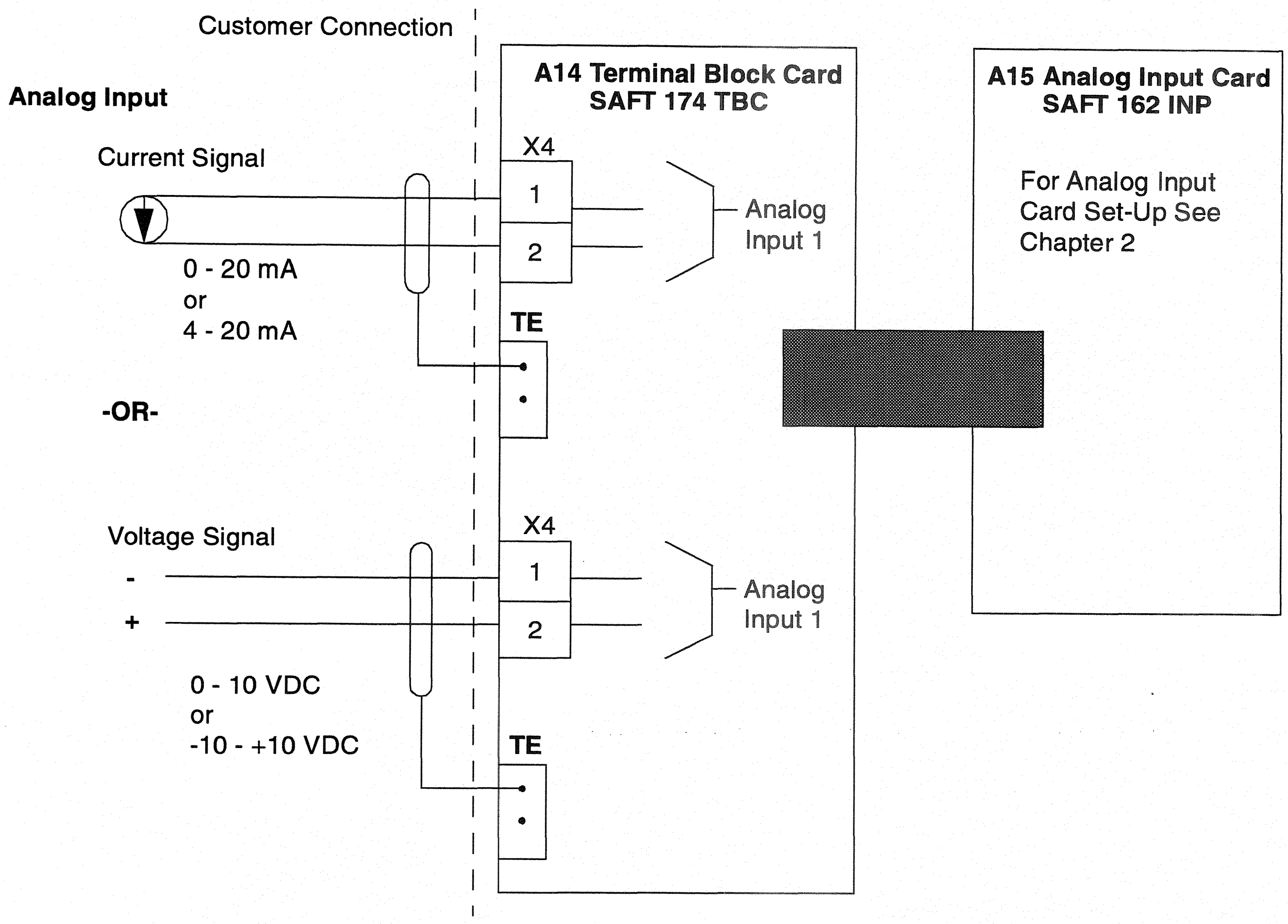


Figure 3-6 Isolated Analog Input Connection

SAFT 162 INPCard

The SAFT 162 INP Card has the following specifications:

• 1 Isolated Analog Input (10 bit Accuracy)	0-10 VDC (max 10 mA)
	-10- +10 VDC (max 10 mA)
	0-20 mA (max 400 ohm)
	4-20 mA (max 400 ohm)

The terminations are made at the SAFT 174 TBC card with the inputs set by the SAFT 162 INP card.

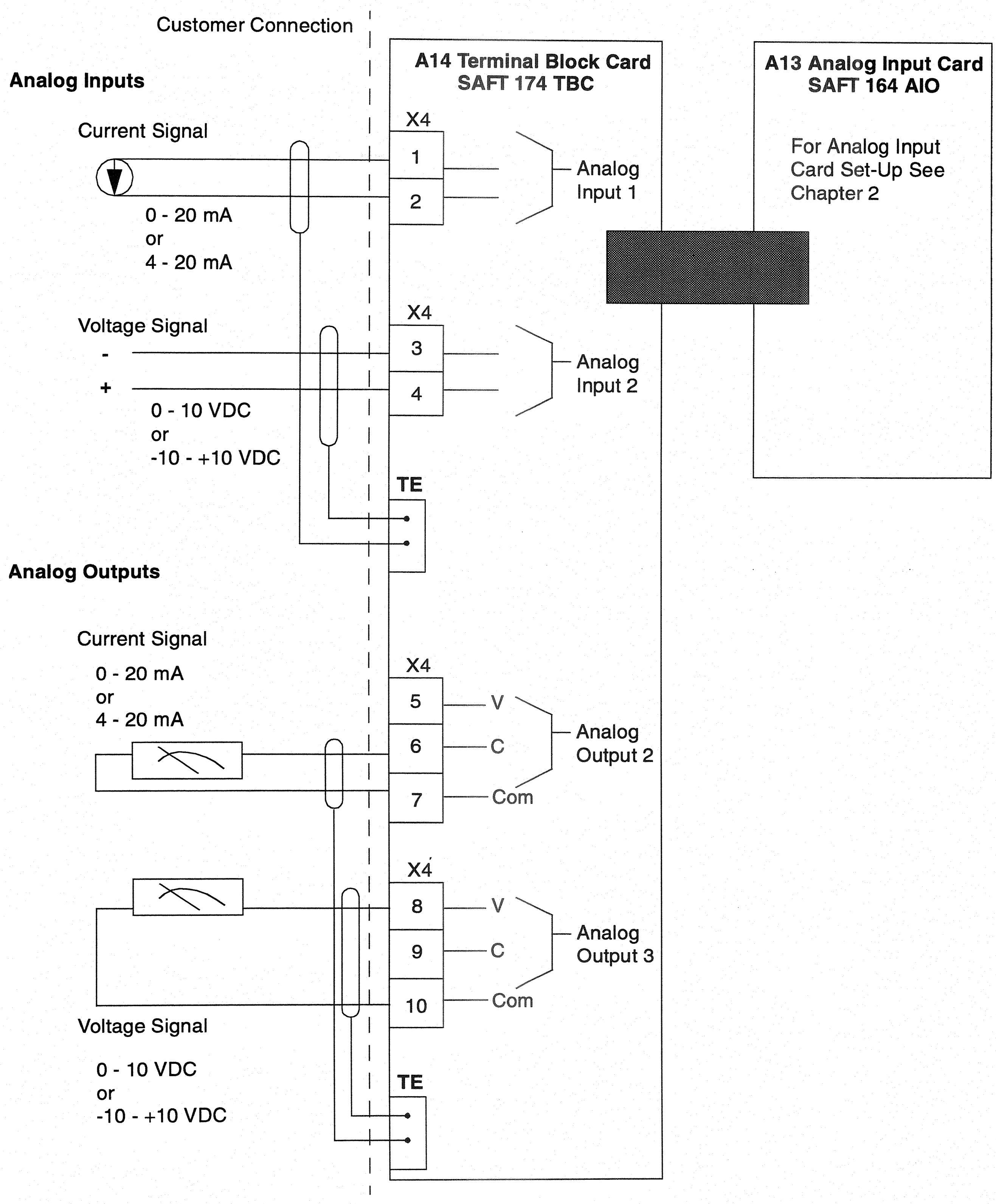


Figure 3-7 Isolated Input and Output connection (SAFT 164 AIO)

SAFT 164 AIO Card

The SAFT 164 AIO Card has the following specifications:

• 2 Isolated Analog Inputs (10 bit Accuracy)	0-10 VDC (max 10 mA) -10- +10 VDC (max 10 mA) 0-20 mA (max 400 ohm) 4-20 mA (max 400 ohm)
• 2 Isolated Analog Outputs (12 bit Accuracy)	0-10 VDC (max 10 mA) -10- +10 VDC (max 10 mA) 0-20 mA (max 400 ohm) 4-20 mA (max 400 ohm)

The terminations are made at the SAFT 174 TBC card with the inputs set by the SAFT 164 AIO card.

SAFT 186 AIO Card

The SAFT 186 AIO Card has the following specifications:

• 1 Isolated Analog Inputs (12 bit Accuracy)	0-10 VDC (max 10 mA) -10- +10 VDC (max 10 mA) 0-20 mA (max 400 ohm) 4-20 mA (max 400 ohm)
• 2 Isolated Analog Outputs (12 bit Accuracy)	0-10 VDC (max 10 mA) -10- +10 VDC (max 10 mA) 0-20 mA (max 400 ohm) 4-20 mA (max 400 ohm)

The terminations are made at the SAFT 174 TBC card with the inputs set by the SAFT 186 AIO card.

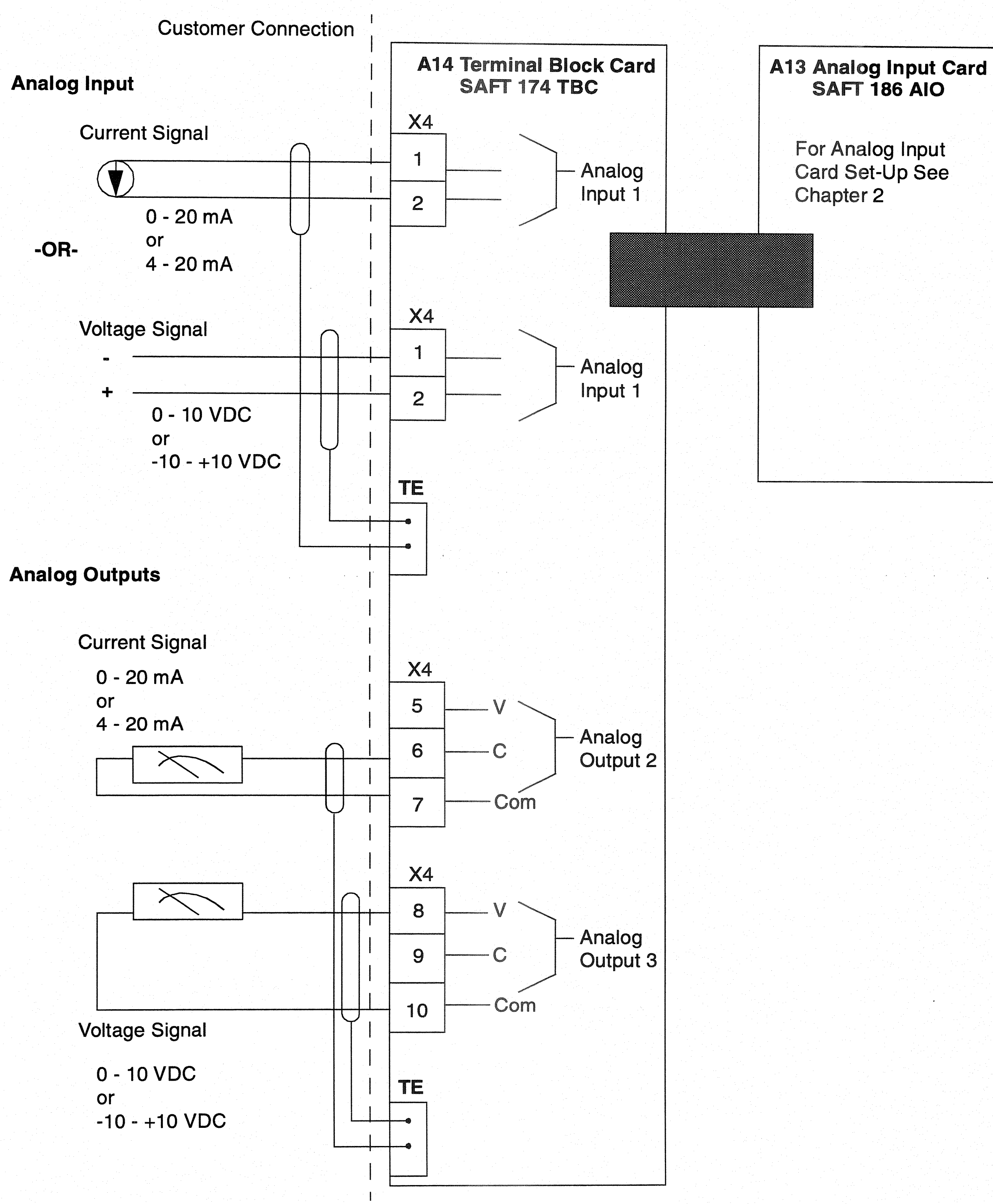


Figure 3-8 Isolated Input and Output connection (SAFT 186 AIO)

Interference Suppression

Harmonic and noise voltage disturbances are present in the supply and output cables of the SAMISTAR Drive. The interference caused by the resulting currents can be reduced utilizing the following methods:

A. Use of cables with a concentric shielded ground conductor.

B. Use of twisted pair shielded wires for control signals.

C. Route the control cables as far away from the power cables as possible and avoid long parallel runs of control and power cables.

Losses and Ventilation Requirements

The power losses experienced in the Drive are nominally less than 2% of the rated power. The Drive is air-cooled with air circulation provided by a cooling fan. The 90 inch tall NEMA Type 1 enclosure requires no clearance side to side, but does require a minimum of three feet in front of the cabinet. The optional Filter kit requires an additional 3 inches of depth.

The ambient temperature of the installation site must be between 0C (32F) and 40C. (104F). In cases where restricted air flow or high temperatures are present, an air conditioned unit or air conditioning of the installation site may be required.

Table 3-5 lists the appropriate air flow requirements.

Table 3-5 Minimum Air Flow Requirements @ 25 C Ambient,3300 feet Maximum

SAMI STAR Rating	Minimum Air Flow Requirements (CFM)
30-50kVA	100
75-115kVA	190
140-180kVA	360
210-290kVA	635
340-460kVA	1165
540-870kVA	1525

CHAPTER 4 - Firmware Description

Introduction

The SAMISTAR AC Drive is factory supplied with a program that controls the gating pulses to the semiconductors. The program cannot be altered, but the parameter values can be adjusted as necessary. Parameters that are typically adjusted during start-up are described herein. The manual provides an overview of the internal interaction of the parameters and serves as a reference document if a problem occurs and the troubleshooting section does not provide a solution.

The SAMISTAR includes the following enhancements for the Scalar Control Program:

- Increased dynamic performance, especially at low rotation speed
- Dynamic slip controller changed to a PI controller
- Dynamic voltage controller changed to a PI controller
- Faster speed controller for increased speed control accuracy
- Variable slope function added to speed integrator
- Additional torque reference selection modes set by Parameter 71
- Serial communication operation at 9600 baud.
- Function Block Programming additions and enhancements

General

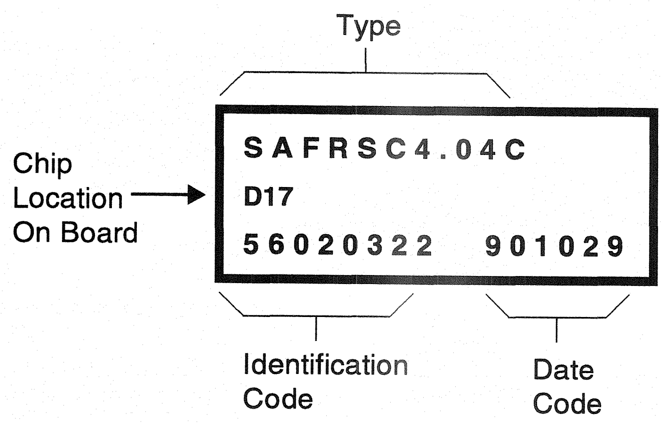
This manual describes the use of the SAMI STAR Scalar Drive employing firmware version:

SAFRSC4.00 FOR SECTIONAL/SINGLE DRIVE STANDARAD VERSIONS

The entire program is stored on two 8 x 64 kbyte (27512) EPROM memory circuits mounted in positions D17 and D18 on the control board.

CAUTION: The memory circuits are not interchangeable with any previous Scalar Control versions.

The firmware components (D17 & D18) on the Control Card employ a type designation as shown figure 4-1. The identification code is an eight digit number used to determine compatibility. The date code utilizes six significant digits.



TYPE CODING

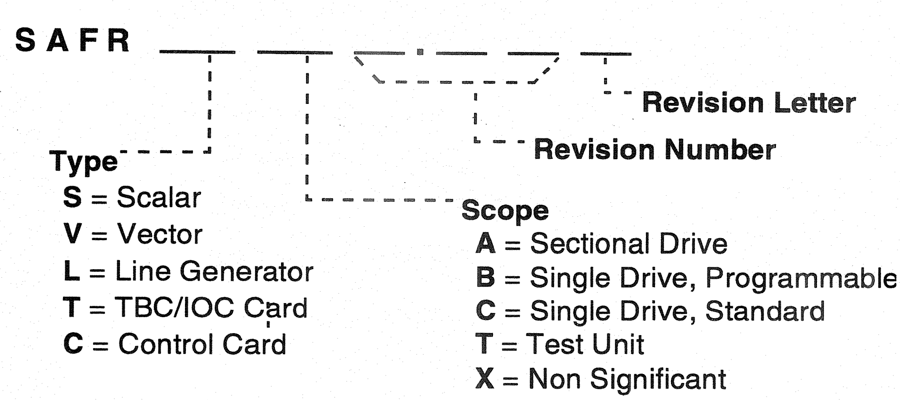


Figure 4-1 Firmware Components Type Designation

Scalar Overview

Scalar Control is based on a static rotor flux model of the squirrel cage induction motor. In scalar control, the motor excitation depends on the frequency requested based on a volts per Hertz curve. Scalar control is normally operated open loop for speed control, controlling the motor with current feedback only. Scalar drive is able to separate the torque producing components and the field excitation components of the current. The basic Firmware diagram is shown in Figure 4-2. The modulator provides the On-Off gating signals to the semiconductors that determine the voltage and frequency to the motor. The numbers shown in the blocks refer to the section number that provides detailed information about that function. The complete Firmware Diagram is shown at the end of this chapter

The frequency reference input to the scalar firmware is determined by the software configuration. This value is processed through a ramp circuit or integrator that provides acceleration and deceleration control for the frequency reference, resulting in smooth frequency changes. This frequency reference signal is modified by several selectable functions some of which are standard features and some are options.

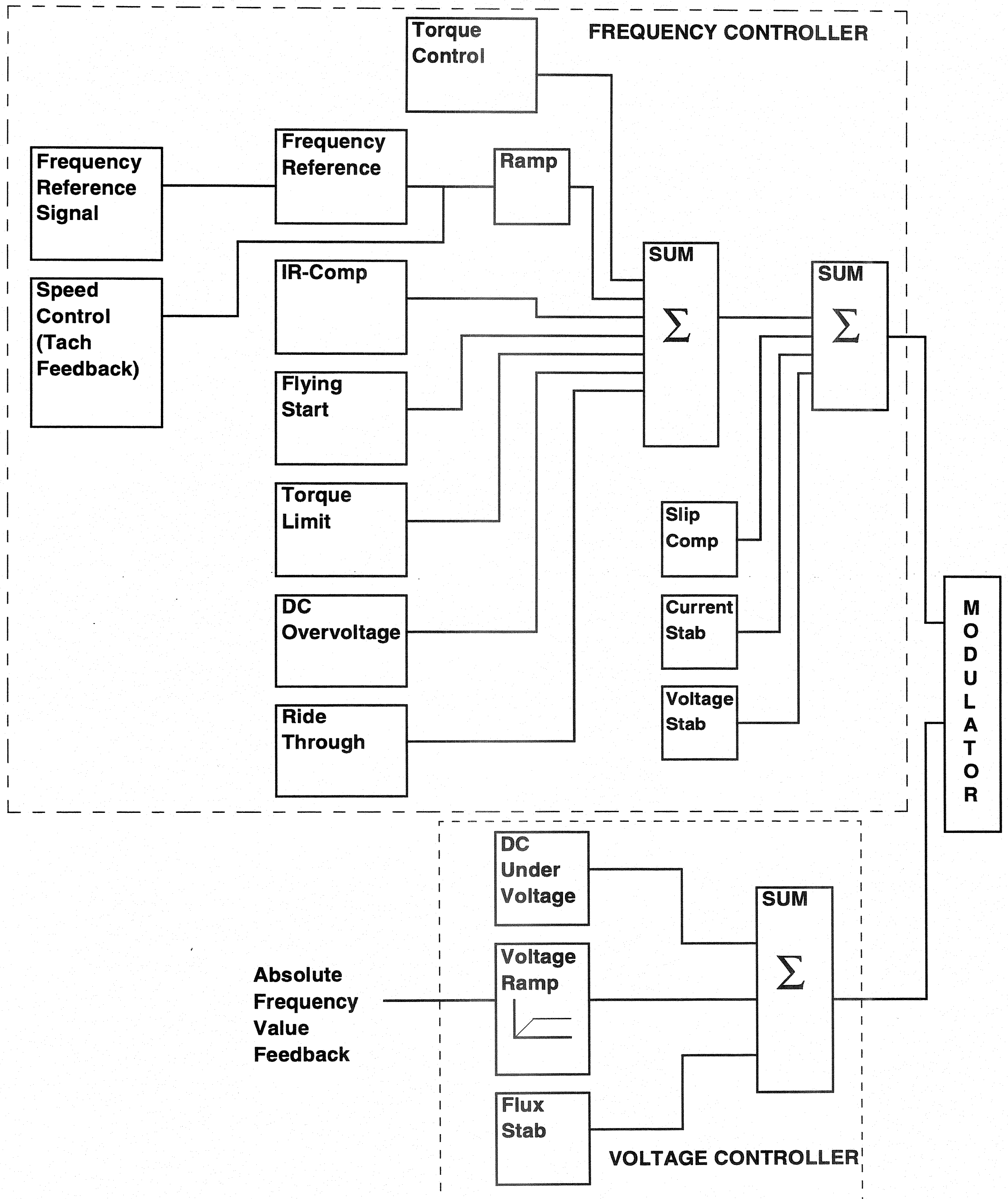


Figure 4-2 Firmware Overview

These modifications to the frequency reference are added together in the summing block and modified further with an optional Slip Compensation circuit and stability functions before being used as the frequency reference to the modulator. This signal is also used as the input to the optional Stall Protection function.

Table 4-1 Functions

Function	Feature
IR Compensation	Standard
Flying Start	Optional
Torque Limit	Standard
DC Overvoltage	Standard
Ride Through	Optional

The voltage controller has modifications only from the undervoltage compensation and flux stabilization circuits. The reference to the voltage controller is the absolute frequency since the output voltage desired depends on the frequency to maintain a constant motor excitation. Again, the voltage reference, like the frequency reference, utilizes a ramp circuit to control the rate of change of the reference.

Selection of Options

The software contains a number of extra application-related functions. Each extra function has its own selection parameter. An extra function selection requires that the function be activated by the manufacturer. Extra functions are dealt with in more detail in the following sections of the manual.

Table 4-2 Options and Selection Parameters:

Description	Designator	Parameter
IR compensation	IRCOMPSEL	85EE*
Stall protection	STALLPROTECTSEL	86EE
Flying Start	FLYINGSTARTSEL	87EE
Power loss control	NETFAILSEL	88EE
Slip compensation	SLIPCOMPSEL	89EE*
Integrator S curve	INTEGMODESEL	91EE*
Trend buffers	TRENDBUFSEL	93EE*
Speed measurement	SPEEDMEASSEL	94EE
Speed control	SPEEDCONTSEL	92EE
DC-braking	DCBRAKESEL	96EE

* The asterisk marked options have been activated at the factory.

Reading Software and Firmware Diagrams

The software and firmware diagrams for the INU follow similar arrangements. Each signal reference and control section is labeled with reference to the section of the manual describing that portion of the diagram. Each section is composed of various function blocks. Two sample blocks are shown in Figure 4-3. The inputs to a function block are shown on the left and outputs on the right. Other parameters affecting the function block are shown above or below the block.

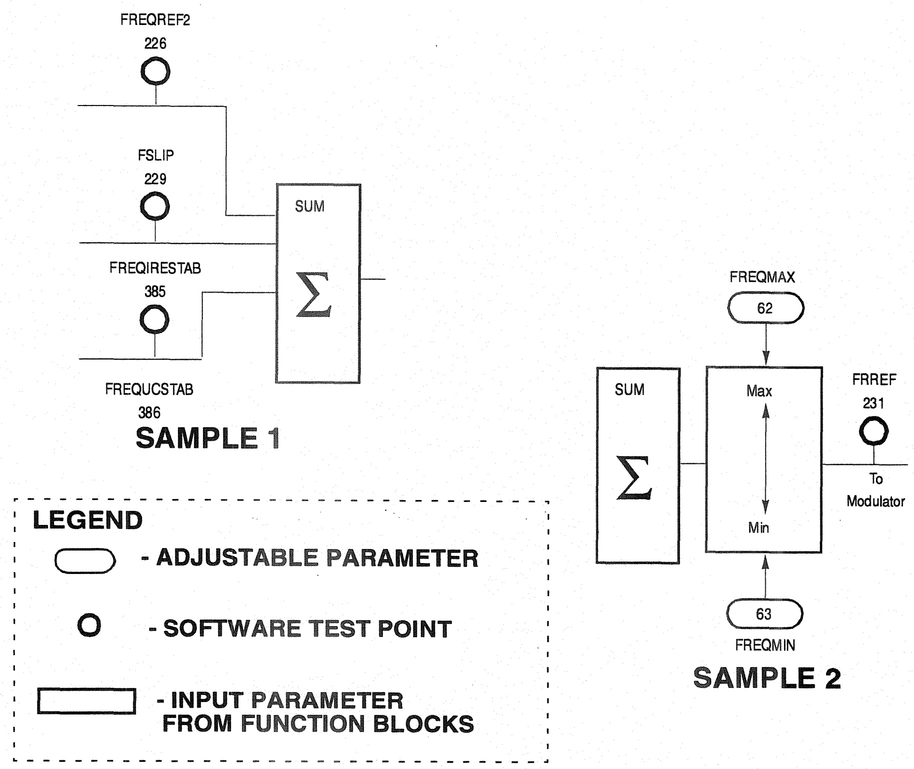


Figure 4-3 Function Block I/O Parameter Example

In the first sample block, Parameters **IRLEVEL 410** and **AUTOTORQMAX 409** are summed to form parameter **IRCOMP 412** which is part of the IR Compensation Circuit. All three of these parameters are provided as test points.

The other sample block which is a part of the Frequency Controller circuit is a limiting function. The frequency reference is limited between the maximum value **FREQMAX 62** and the minimum value **FREQMIN 63**.

Memory

Parameters are stored in RAM memory locations and are accessed the in the operation of the control program. Some parameters can be thought of as test points; a display is used to check their values instead of a meter. Others can be used to store setpoints and tune-up information similar to the way potentiometers were used in analog circuits. On loss of power to the control card or shut down of the drive, all information stored in RAM is lost.

Vital parameters are stored in battery backed RAM or can be backed up to nonvolatile EEPROM. Vital parameters are those used for troubleshooting, or those set during start-up, tuning, and application software programming.

In this manual, when referring to the communication table, each parameter has a type identifier as follows:

- **Blank** Measuring point in general, the value is not saved.
- **M** Measuring point which is protected by battery backup.
- **EE** Parameter which can be saved to EEPROM.

The RAM parameter table is restored on power-up by first clearing it and then moving the EE parameters from EEPROM to RAM. The integrity of the parameters in EEPROM is monitored by a checksum. If the checksum fails, the drive issues a “NO BACKUP/NEW EEPROM” (SA50) message after loading the EEPROM with default values from the program EEPROM. To prevent inadvertent operation of the drive with default parameters, it is necessary to cycle power on the drive before it will start. The proper parameters must be loaded into the drive before attempting to start the drive.

It is possible to write the RAM parameter table to EEPROM only when the hardware enable jumper S4 is in the a-b position and when **EEPROMLOCK 8T** is non-zero. If an attempt is made to write to EEPROM with S4 in the a-c position, SA52 is displayed. A successful write to EEPROM causes the message SA51 to be displayed while the write is in progress. The **EEPROMLOCK 8T** should be set to 0 after the write is complete (2 minutes or less) to prevent excessive writing to the EEPROM. If power is interrupted to the control card, **EEPROMLOCK** will set itself to 0.

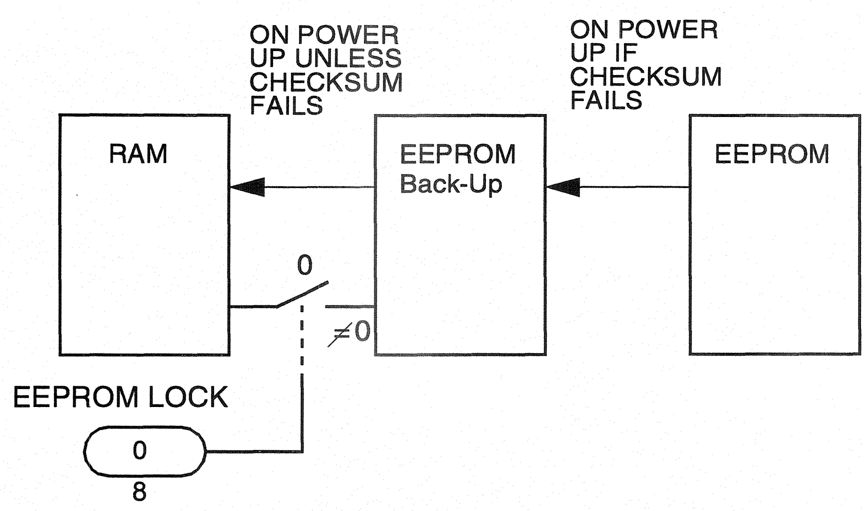


Figure 4-4 Parameter Backup

CAUTION: The proper parameter values must be loaded into the drive before operation. The default function block software does not match the ABB standard software and must be reloaded. Some of the optional features on the Scalar drive will be lost and can be reactivated by an ABB Industrial Systems Inc. representative only.

Memory Battery Backup

The SAFT 187 CON Control Card includes a small nickel-cadmium battery which retains diagnostic data in memory when the power is disconnected from the card. This battery backup is connected in the circuit when jumper S3 is in position a-b. The battery should be disconnected for storage of the card. If the battery is discharged or disconnected, the drive will display the message SA56. If the battery is discharged, it takes approximately 30 hours for it to recharge. A fully charged battery retains data for approximately 100 hours. In the event of a supply voltage failure, the program stores the following data to battery protected memory locations:

- Fault words **FAULTWORD0-2** 210 TM to 212 TM
- Fault buffer **FLT-QUEUE** 176 TM to 181TM
- Trend buffers **TRENDBUF1-8** 500 TM to 1299TM
- Fault display (FL)
- In addition, 12 additional parameters can be sorted to the memory by means of the application program RAMSTORE function block.

CAUTION: The proper parameter values must be loaded into the drive before operation. The default function block software does not match the ABB standard software and must be reloaded. Some of the optional features on the Scalar drive will be lost and can be reactivated by an ABB Industrial Systems Inc. representative only.

Status Command Word

Use of the **STATUS-CMD 13** command word - All the inverter's control commands can be given by means of the packed bit-coded command word **STATUS_CMD 13**.

When the **STATUS_CMD** is in use (the content is <>0), no commands are accepted from the control parameters **START 2**, **START1_P 24**, **START2_25** or **STOP 3**. A **RESET 12** is permitted and it also resets the **STATUS_CMD 13**.

The inverter can be either speed, frequency or torque controlled by means of the **STATUS_CMD 13**. Bits 1 (STOP by current limit) and 10 (bypass of the speed integrator) only function when the inverter is speed controlled.

When the **STATUS_CMD 13** and the functional block software are used, the SCALAR-block control word connections are:

START1	1386	=	2
START2	1387	=	24
START3	1388	=	25
STOP	389	=	3
STOP2	1390	=	22

The meaning of the **STATUS_CMD 13** bits are:

0 = STOP by ramp

1 = STOP by current limit.

The input and output of the speed integrator are set to zero and the drive stops when speed controlled on the preset current limits.

2 = COAST STOP

The inverter is shut down immediately.

3 = Not Used

4 = Not Used

5 = Not Used

6 = START at 27/29 speed (speed reference/frequency reference)

7 = START at 167EE/161EE speed

8 = START at 168EE/162EE speed

9 = RESET

Note! This control resets the **STATUS_CMD 13**.

10 = Bypass of the speed integrator.

The speed reference is transferred direct to the integrator output **ROWSPEEDREF2 295** and to the rounding function output **SPEEDREF2 233**.

11 = Not Used

12 = Not Used

13 = Not Used

14 = Not Used

15 = Not Used

COASTSTOP 22 is not in the circuit since it turns off all regulators and the modulator. The selection is made via the software function blocks . The selected reference is stored in parameter **FREQREF1 225** and becomes the input to the ramp. The frequency reference parameters are set in 0.01 Hz increments so that 600 is equal to 60.00 Hz.

The Ramp block provides separate acceleration and deceleration times as set by **FREQINTACC 64** and **FREQINTDEC 66** respectively. The scaling of the accel and decel parameters is in 0.1 second intervals to change frequency 100 Hz. The default values of 200 give an accel and decel rate of 100 Hz in 20 seconds. The minimum setting is 10 which equates to 100 Hz in 1 second and the maximum value is

6000 which equals 100 Hz in 600 seconds (10 minutes). The decel rate is dependent on the system being able to dissipate the regenerated power from the motor. If no additional braking is provided, the decel rate will be determined by the ability of the drive to absorb the regenerated power and not the decel setting.

Frequency Controller

FREQREF 29, **FREQ1 161** and **FREQ2 162** are the three possible frequency reference signals. **FREQ1** and **FREQ2** are used for preset reference values such as a thread or jog application. **FREQREF** is the normal frequency reference signal used for run.

The Frequency Controller is shown in Figure 4-5.

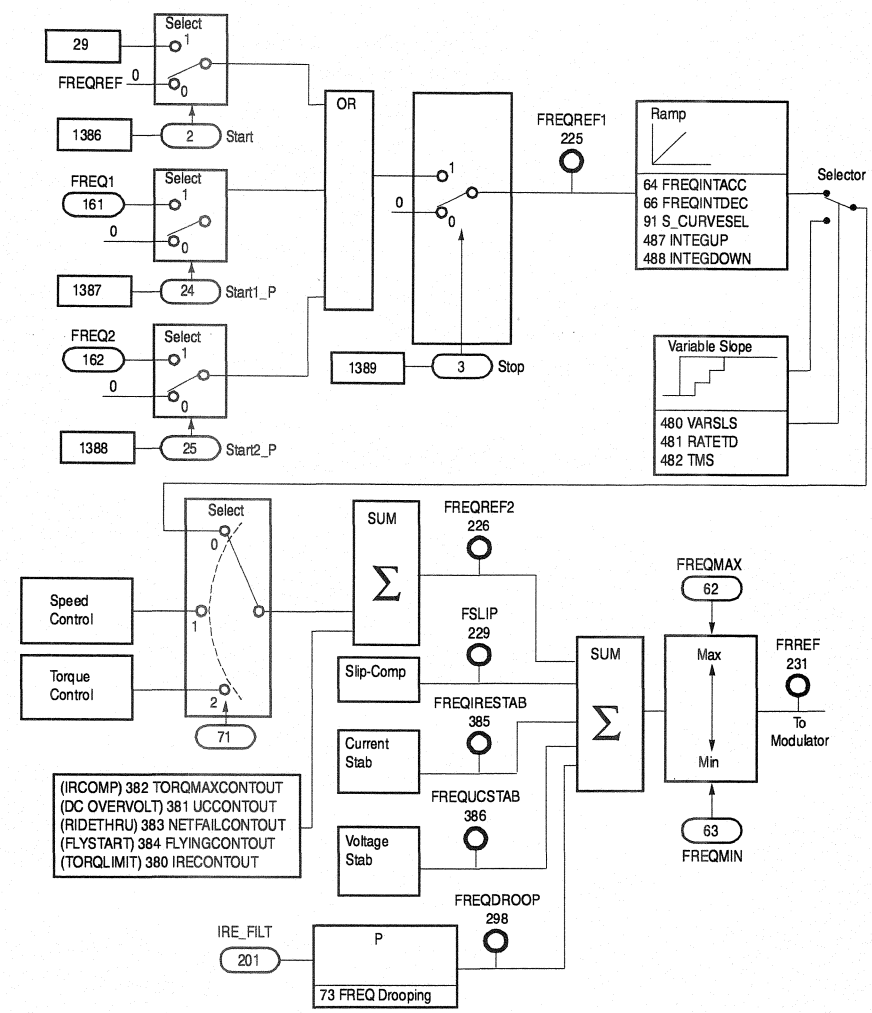


Figure 4-5 Frequency Controller Block Diagram

The frequency reference is selected via the start signal used. **START 2** is used to select the normal reference **FREQREF 29** while **START1_P 24** is used to select **FREQ1 161** and **START2_P 25** selects **FREQ2 162**. **STOP 3** is used to select a zero reference, thus causing a ramp stop. The inverter is stopped when the frequency, or the frequency measured on the motor shaft (**FACT 239**) has dropped below the value set by parameter (**STOP_FREQ 77EE**).

A stop or start-up command can be given in an arbitrary sequence but only the last request remains in force. When stop and start-up requests come at the same time, the inverter stops. When the inverter has stopped, a new request can be initiated only after the restart delay set by the parameter **RESTARTDELAY 75EE** (0...20s, factory setting 3s). If start-up attempt is made while a stop command remains continuously in force, CP-1 displays the "SA58"

Parameter **S_CURVESEL 91** selects a modified accel and decel rate that instead of providing a constant accel, provides a constant rate of change of acceleration at the endpoints. This modifies the velocity curve so that it resembles a slanted "S", thus the name S-Curve. This feature is selected as a default and can be eliminated by setting **S_CURVESEL** to zero if extremely rapid accel rates (<3s) are required. The gain of the S-Curve function is determined by **INTEGUP 487** and **INTEGDOWN 488**. The default settings are 2000 and 800 respectively. The greater the gain, the faster accel or decel become linear. Normally, this will not require adjustment.

The output of the ramp block is summed to the various modifying functions discussed in the following sections.

IR-Compensation adjusts the voltage at low frequencies to compensate for the resistance of the motor which causes the relationship between voltage and excitation to be non proportional.

DC-Overvoltage control increases the frequency reference if the Bus voltage goes too high during regeneration.

Ride-Thru controls the decrease in frequency during power outages. By using the power regenerated from the motor, the inverter can be kept in operation so that it can be reaccelerated when power becomes available.

Flying Start allows the inverter to start a motor that is still rotating due to inertia without waiting for it to coast to a stop.

Torque Limit provides the ability to limit the maximum torque that the motor can produce by reducing the frequency if the set torque is being exceeded.

Slip Compensation adjusts the frequency according to the slip of the motor to provide a closer control of speed during load changes.

Current Stabilization dampens the frequency response to load fluctuations and has individual gain adjustments for each pulse number for the modulator.

DC Voltage Stabilization dampens the frequency response to fluctuations in the DC voltage. The stabilization circuits are preset and should not require adjustment. If it is felt that adjustment is necessary, contact you area ABB Industrial Systems Inc. for assistance.

Frequency Droop a standard feature of the drive is the ability to make the frequency reference decrease as the current increases. The active current **IRE_FILT 201** is multiplied by Parameter **73 FREQDROOPING**. The result is **FREQDROOP 298**.

Parameter 73 is adjustable from 0 to 1000. At 1000, the frequency would be reduced 10 Hz when the active current is at full scale. This feature has the opposite effect of Slip Compensation, since Droop decreases the frequency with load and Slip Compensation increases the frequency with load. One potential use of this feature would be when load sharing is required between two drives.

The final modification to the frequency reference is to limit its range. The maximum limit is defined by **FREQMAX 62** and the minimum limit is defined by **FREQMIN 63**. The output of the limit block is **FRREF 231** which is sent to the modulator to control the drive frequency.

Voltage Controller

Since the motor requires a constant excitation level, the Voltage Controller controls the volts per hertz to the motor rather than just voltage. The input to the Voltage Controller is the absolute value of frequency **ABSFREQ 228**. The absolute value of frequency is the frequency without the direction sign. **ABSFREQ** goes into a ramp generator that produces the voltage ramp as a function of frequency. This ramp starts at zero and is clamped at the value as defined by the setting of **MAXOUTPUTVOLTAGE 67. MAXOUTPUTVOLTAGE** has a range of 0 to 120 which is scaled in percent of rated AC voltage. If **MAXOUTPUTVOLTAGE** is set to 100, this means that the output voltage will not exceed rated voltage even though the input voltage goes above rated. The frequency that corresponds to maximum output voltage is set by **FIELDWEAKPNT 68** which has a range of 2000 (20.00 Hz) to 20000 (200.00 Hz) and a default setting of 6300 (63.00 Hz). At frequencies above the setting of **FIELDWEAKPNT**, the voltage is clamped at **MAXOUTPUTVOLTAGE.** The output of the ramp is stored to **EMFVECTOR 286** and becomes the input to the maximum value selector **MAXVAL** block.

The **MAXVAL** block compares the two inputs, **EMFVECTOR 286** and **UFIR 27**, and selects the greater value as the output **UFIRUFEF 283**. **UFIR** is the voltage reference output from the IR compensation circuit which is described in Section 4-9. In a similar manner, the **MINVAL** block selects the smaller value of **UFIRUREF 283** and **FLSTARTUREF 288** as the output **NORMALUREF 284**. **FLSTARTUREF** is the voltage reference output of the Flying Start function. NORMALUREF becomes the primary reference value to the summing block.

Another input to the summing block is the Undervoltage control which is developed from the filtered DC voltage feedback **UCFILT 277**. This circuit compensates for a low DC bus by determining the percentage that the DC bus is low and adding that amount to the AC voltage reference. The first block determines the amount that the DC voltage is low by subtracting the feedback from 1000.

The difference is multiplied by **NORMALUREF** to determine the drive operating point. The output of this block is divided by 1000 for proper scaling and the output is stored to **UCEMF 282** and is sent to the summing block. If the DC voltage is 10% low, it will add 10% to **NORMALUREF** as compensation in the summing block. The Voltage Controller is shown in Figure 4-6.

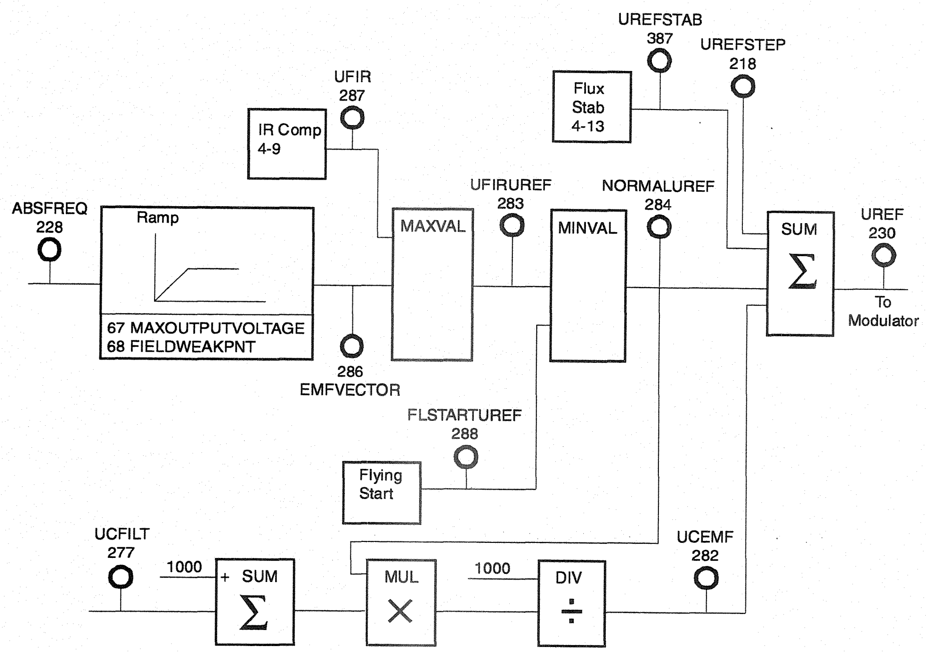


Figure 4-6 Voltage Controller

A third input to this summing block is the Flux Stability output **UREFSTAB 287**. This circuit is set at the factory and should not require adjustment. If it appears that there is a stability problem, contact ABB Industrial Systems Inc. for assistance.

The fourth input to this block is **UREFSTEP 218** which is provided for test purposes only and should be set to 0. The output of the summing block is stored to **UREF 230** and becomes the input to the modulator that controls the output voltage.

Variable Slope Function of the Frequency Integrator

The Variable Slope Frequency Ramp is intended for use with external serial communication devices such as a PLC which sends data to the drive at various interval/update rates. This function is intended to smooth discontinuity in reference data. When the Variable Slope function is activated, the program independently computes the required integration rate. The computation is based on the program cycle time of the higher-level computer and on how much the frequency reference changes when it is updated. The time during which the reference has changed is given by means of parameter **462EE TMS**. This data is used in computing the required integration rate at 21 ms intervals.

Parameter **461EE RATED** determines the time delay required from the start of the inverter to the activation of the Variable Slope function. During calculation of the time the standard integration parameters **64EE FREQINTACC** and **66EE FREQINTDEC** of the inverter are used.

The Variable Slope function is not used during the Stop command.

Setting Parameters:

460EE	VARSLS Activation of the function 0 = function not activated, 1 = function activated
461EE	RATETD Time from start to activation of the function, 1 =1s
462EE	TMS Frequency reference updating interval on the higher-level computer, 100 = 100ms

IR Compensation (Torque Maximization)

At the low frequencies (0 to 10Hz) a significant voltage drop is produced by the stator resistance of the motor. The IR drop is compensated by boosting the output voltage of the inverter such that the proper magnetization is achieved. The IR Compensation is required when load torque is present beginning from the zero frequency (release torque).

The IR Compensation Function Block comprises four functions:

- Developing a motor flux.
- Calculation of additional voltage.
- Peak current limiting control.
- Automatic search of maximum compensation.

IMPORTANT: *All modes of IR Comp are not compatible with the flying Start Option. If both features are required, consult ABB Industrial Systems Inc.*

The selection for IR-compensation is determined by **IRCOMPSEL 85**. If **IRCOMPSEL** is set to zero, there is no compensation. This would be a situation where full torque is not needed at low frequency, such as a variable torque load. If **IRCOMPSEL** is set to 3, the program determines the amount of voltage boost using Automatic Search. When **IRCOMPSEL** is set to 1, the compensation is set manually. In the application where IR Compensation is required, automatic search is normally used.

The IR Compensation Diagram is shown in Figure 4-5

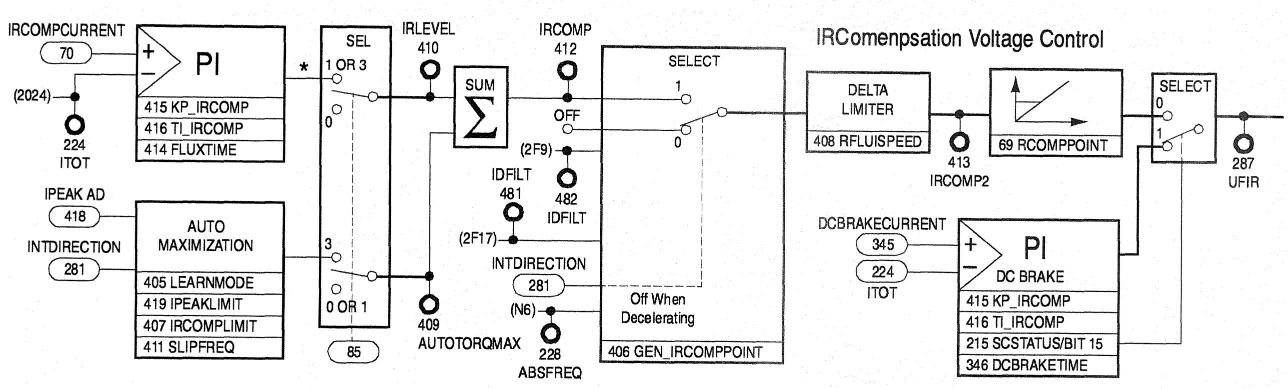


Figure 4-7 IR Compensation *Block Diagram*

Automatic Search of IR Compensation

When the IR Compensation requirement of the drive significantly varies, the start-up can be facilitated by switching on the automatic search function. This is done by setting **IRCOMPSEL 85EE** to 3 and **LEARNMODE 405EE** to 1. The Automatic Search circuit increases the additional voltage if the drive reaches the peak current limit. The increase of voltage decreases the frequency reference value by means of the Peak Current Controller until the drive starts to operate. If the drive is not able to start the increase of voltage is terminated at the slip frequency.

The program stores the value of the additional voltage used by the automatic search circuit to the measuring point **AUTOTORQMAX 409EE.** This value can be used in a subsequent start-up instead of the Automatic Search by setting the **LEARNMODE 405EE** to zero after the first start-up (motor running). **LEARNMODE 405EE** can be left at any non-zero value and the drive will search on each start.

Constant Voltage IR Compensation

IR compensation is given directly as a voltage addition when **IRCOMPSEL 85EE** = 1 and **IRCOMPVOLTAGE 420EE** <> 0. Additional voltage which is determined by the parameter **420 EE** will be given to motor in the whole frequency range.

The motor flux has to be developed before the motor can be rotated. Flux is developed by means of PI controller, which is turned on after receiving the START command. The start time is determined by the parameter **FLUXTIME 414EE.** The PI controller regulates the total current of the inverter **I-TOT 224** with the reference value defined by the parameter **IRCOMPCURRENT 70EE.** After the developing of the flux, the program stores a voltage reference value to the parameter **IRLEVEL 410.** This value is used by the IR Compensation circuit as the voltage reference at the zero frequency. The IR Compensation gain or voltage boost is therefore selected by means of the parameter **IRCOMPCURRENT 70EE.**

Calculation of Additional Voltage

The additional voltage provided by the IR Compensation is produced at zero frequency on the basis of the parameter **IRLEVEL 410** content. As the frequency increases the additional voltage is linearly reduced and eliminated at the frequency defined by the parameter **IRCOMCPOINT 69EE**.

Additional voltage is not produced if the drive is in the generator mode. When the drive changes from the generator mode to the motor mode or vice versa, The rate of rise of the voltage is limited by the parameter **IRFLUXSPEED 408EE**.

Peak Current Control

At low frequencies the active current becomes less accurate. When the IR compensation operates at a frequency below the limit defined by the parameter **IRCOMPLIMIT 407EE** (5 Hz) the current limiting control is based on the peak current measurement.

DC Overvoltage Control

The DC Overvoltage Control prevents the DC voltage from increasing to the trip point during regeneration.

The control is composed of two proportional type controllers with separate reference values. **UC HIGH 354** is the reference for the "higher" control and is normally set to 119% of the rated DC voltage. The "lower" control uses reference **UCHIGHREF 355** which is normally set to 116% of the rated DC voltage. The feedback signal for both controls is **UCAVG 227**. When the feedback increases above 116%, the lower control is activated and increases the frequency to reduce the DC voltage. if the feedback rises above 119%, the higher control is activated and increases the frequency at a faster rate. The gain of the controls are **KP_UCHIGH 356** for the higher control and **KP_UCHIGHREF 357** for the lower control. The output of the two controls are summed and stored to **UCCONTOUT 381** which is sent to the summing block that determines **FREQREF2 226**. When the DC voltage falls below the setting of **UCHIGHREF**, the gain is incremented toward its default value.

The DC Overvoltage Diagram is shown in Figure 4-8.

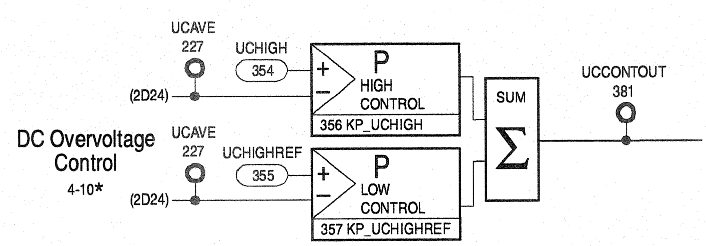


Figure 4-8 DC Overvoltage Block Diagram

Torque Limiting Control

The Torque Limiting Control allows maximum torque to be set for the motor. This may be used to guard against exceeding the current capabilities of the inverter or of the connected load. This limit is based on the active component of the current which is proportional to torque. Below 10 Hz the drive utilizes total output current **IRE-FILT201**, not just the active component.

The Torque Limit Diagram is shown in Figure 4-9.

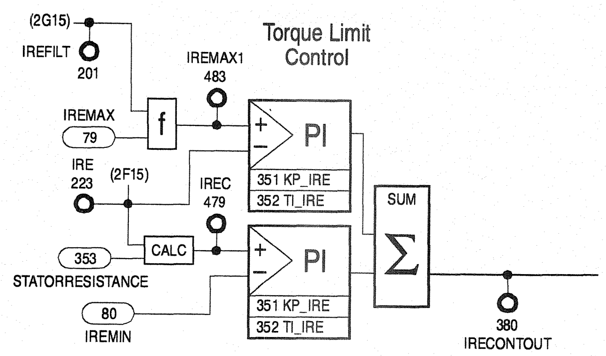


Figure 4-9 Torque Limit Block Diagram

Two controllers are used, one for motoring and one for generating mode. Both are PI type and use the same gain parameters. **KP_IRE 351** is the gain of the P portion and **TI_IRE 352** is the gain of the I portion. The references are **IREMAX 79** and **IREMIN 80**. In the motoring mode, the active current component contains a high frequency ripple so the reference signal is filtered through a function block to obtain **IREMAX1 483**. In the generating mode and at low frequencies, the effect of the motor stator resistance becomes greater and IRE is corrected by **STATORRESISTANCE 353** to form **IREC 479**. The controls are activated when **IRE 223** exceeds the limits of the controller (**IREMAX1** or **IREMIN**). The outputs of the controllers are summed and stored to **IRECONTOUT 380** and sent to the summing block that forms **FREQREF2 226** in the frequency reference circuit.

Slip Compensation

Slip Compensation Figure 4-10 is an option used to improve the speed regulation of the drive without the use of tachometer feedback. It is selected by **SLIPCOMPSEL 89** (-1=ON).

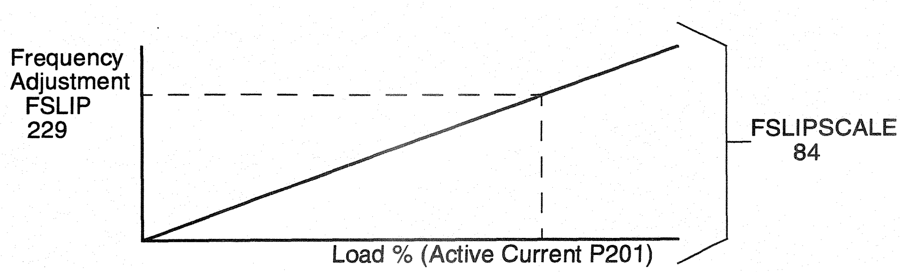


Figure 4-10 FSLIP vs. Load

The output frequency is increased by an amount proportional to the load (average active current **IREFILT201**). The maximum amount of Slip Compensation is set with **FSLIPSCALE 84** and the output is **FSLIP 229** (100=1Hz). **FSLIPSCALE** should be set equal to the full load slip frequency of the motor in 0.01 Hz increments (100 = 1 Hz.). Slip compensation is not active below 10 Hz.

Stabilization

There are three stabilizing circuits used in the inverter which dampen current fluctuations in low-load conditions and voltage fluctuations in fast transient states. The torque stabilization circuit dampens the frequency response to load fluctuations and has different gain adjustments for each of the pulse numbers from the modulator. The DC voltage stabilizer also dampens the frequency when changes are caused by fluctuations in the DC voltage. The third stabilizing circuit is the flux stabilization which dampens the output voltage at light load. The stabilization circuits should not need adjustment. If it appears that stability is a problem, contact ABB Industrial Systems Inc. for assistance.

Torque Stabilization

The torque stabilization circuit uses the active current **IRE223** as the input to the derivative controller and each pulse pattern has its own gain parameter. The parameter used for gain and the corresponding frequency ranges are listed in table 4-3.

Table 4-3 Stabilization Parameters

Name	Parameter	Range
IRESTABGAIN_VP1	359	60[1] to 200 Hz
IRESTABGAIN_VP3	360	30 to 60[1] Hz
IRESTABGAIN_VP5	361	25 to 36 Hz
IRESTABGAIN_VP7	362	10 to 25 Hz
IRESTABGAIN_VP9	363	10 to 20 Hz
IRESTABGAIN_VP11	364	0 to 10 Hz
IRESTABGAIN	365	0 to 200 Hz
SLIPFREQ	411	0 to 200 Hz

[1] Actual field weakening point Parameter 68 or 81 whichever is least. Default value is 63 Hz.

DC Voltage Stabilization

The voltage stabilization circuit uses the average DC voltage **UCAVG227** as the input to the derivation controller. The gain is set by **UCSTABGAIN370** and the time constant by **UCSTABFACTOR 371**. The output is **FREQUCSTAB 386** and is sent to the final summing block that forms **FRREF231**.

Flux Stabilization

The flux stabilization circuit dampens the output voltage under light load conditions. The input is the reactive current **IQ222** and absolute frequency **ABSFREQ228**. The gain is determined by **FLUXSTABGAIN** 367 and the time constant by **FLUXSTABFACTOR368**. The output is stored to **UREFSTAB 387** and is sent to the final summing block that forms **UREF230**.

DC Braking

After a STOP command, when DC braking is activated, the motor will be supplied with a current determined by parameter **DCBRAKECURRENT 345EE** on a frequency 0.2Hz.

The braking capacity of DC braking is about the same as with the braking by using the drives internal losses (UC-overvoltage activated). DC braking will allow a stable stopping of the load.

The operation of program during the braking:

- The modulator triggering pulses are taken off for a period **RESTARTDELAY 75EE**.
- Drive is started on a frequency 0.2 Hz.
- Motor will be supplied with a total current which is determined by a ramp and controller. The reference value is **DCBRAKECURRENT 345EE** and the actual value **I-TOT224**.
- Motor will be supplied with a current during a time which is determined by a parameter **DCBRAKETIME 346EE**. When time has elapsed the drive will be stopped. Time can be changed during the braking.
- Supplying of the current will be stopped by a fault trip or if the drive receives a **COASTSTOP** command.

Stall Protection

The stall protection stops the inverter when the motor is in apparent danger of overheating. The rotor is either mechanically stalled or the load is otherwise continuously too high.

The stall protection is activated if the inverter's total current exceeds the rated value and/or the torque limit control is turned on at least for the time defined by the parameter **STALLTIME 83EE** and assuming that the output frequency is below the limit set by the parameter **STALLFREQ 82EE**.

When the inverter stops, the fault code ”FL20” is displayed on control panel CP1.

Star Modulation

The modulator is a program segment which controls the power semiconductors so that AC power of the desired frequency, phase and volts is generated. The drive modulator is optimized to minimize distortion in accordance with the star modulation theory. The star modulation method was developed for fully digital control, to provide superior performance required by some applications.

These special requirements include:

- Zero Frequency.
- Zero Voltage.
- Reversing at zero voltage.
- Voltage control over entire frequency range.
- Torque regulation down to zero frequency (requires vector control).
- Virtually no cogging, even at less than 0.5 Hz.

Two modulation methods are used at meet these requirements:

1. Asynchronous: The number of voltage pulses per second remains constant. This makes zero frequency and smooth reversing possible and minimizes current distortion.
2. Synchronous: The number of main voltage pulses per half cycle remains constant. This permits smooth running at high frequencies. The pulse numbers are so selected that the current distortion remains minimal.

Asynchronous modulation is used in the range of approximately 0 to 20 Hz. and synchronous in the range from approximately 20 Hz to 200 Hz. Six different pulse numbers are used for synchronous modulation. The approximate transition points are listed in table 4-4.

Table 4-4 Star Modulation Transition Points

Pulses/Half Cycle	Output Frequency Range (Hz)
27	20 to 29
19	29 to 41
11	41 to 50
3,5, or 7	50 to FWP(Field Weakening Point) or 100
3 or 5	100 to 150
3	150 to 200

IMPORTANT: *One Pulse per half cycle is equivalent to a six step waveform.*

There is some hysteresis in the modulation control so that when the average output frequency is at a point where the pulse number changes, the control will not toggle between pulse numbers, but will remain at the pulse number depending upon whether the frequency was increasing or decreasing just before the operating frequency was reached.

In the higher frequency ranges, when the pulse number is 3 through 11, it is possible for the control to transfer to a pulse number of 1 at any frequency required by the voltage reference which would represent a six step waveform.

Bus Voltage Measurement

The intermediate circuit DC voltage (Uc) is continuously measured through the A/D converter. The converter output value is scaled so that 1000 corresponds to the rated Uc voltage. The scaled value produced is the DC voltage actual value **UC-ACT207**. This can be used further to compute the filtered actual value of DC voltage **UCFILT 277**.

The filter time constant used is **UCFILT FRE 276EE**.

UCNOMINAL 259 gives the DC voltage rated value in volts.

Bus Voltage Measurement Calibration - The Uc measurement calibration function operates only on request. It can be used if the Uc measurement error has a significant value. The program allows us to eliminate measurement errors of 5%. A calibration is performed as part of the Start-up Procedure.

Phase-current Measurement

The inverter output current is measured by means of Hall effect sensors. The signals transmitted from the sensors are converted in a VC/F transcript into a frequency which is proportional to the current. The frequency that corresponds to zero current is offset so that with positive currents the frequency is higher than the offset frequency and with negative currents it is lower than the offset frequency.

Output Current Zero-Point Error Compensation - The zero-point error compensation always functions when the inverter is not running. A 5% offset is the highest offset value the program can eliminate in current measurement. The current measurement offset limit is determined by the parameter Current offset **190EE**.

The current measurement circuit of the CON control card can be adjusted as described in the Start-up Section.

Calculating the Active Current and Total Current - The **IR 219** and **IS220** phase currents are average values from the modulation cycle time. The currents are transformed by means of a 3/2 coordinate transformation to denote a phase current in the stator coordinate system. The transformation yields current components **IA 279** and **IB 280** which are perpendicular to each other. **IA** and **IB** are transformed to voltage coordinated by means of modulator **ANGLE498**. The transformation yields an active current **ID221** and a reactive current IQ222. ID is corrected for a power factor of 0.87 to give **IRE223**.

This value is filtered using **IREFTR-FAST 485EE** as the time constant in running start and power loss control modes and **IREFTR-SLOW 486EE** normal run to give in **IREFILT201**.

These current components can be used to compute the magnitude of the current vector. The result obtained is the unfiltered total current actual value **I-TOT224**, from which the filtered current actual value for the control panel display **CURACT 205** can be computed as an average value at slower time interval.

Peak Current and Current Balance Measurement

An analog hardware connection is used to check the inverter output currents continuously, in order to prevent over-currents. The hardware connection can be used also to store the peak currents which are converted into a numeric value **IPEAK 244** by means of an A/D converter and then transferred to the control unit. The measuring point is updated at 24 ms intervals.

The **IPEAK ADS 418** measuring point contains the peak current value measured by the A/D converter. The content of 418 is updated at approximately 1 to 3ms intervals.

An asymmetry of the currents is a sign of a possible fault, e.g. a short circuit in a phase. The drive continuously computes the maximum difference between the peak values of the phase currents, and save the computed value as a parameter. The parameter can then be utilized, for example in applications implemented by means of functional blocks.

During start-up of the inverter, earth-fault and short-circuit tests are executive on GTO inverters and the **IPEAK 244** peak current is checked to find out if it exceeds the set normal limit **E-S Limit 275EE**.

Protective Circuits

In addition to the Active Current Limit Control, an additional protective circuit is provided to help minimize nuisance overcurrent tripping. This circuit, Reset Overcurrent Protection Circuit (ROPC) momentarily turns OFF the main semiconductors if a current spike reaches 230% of the inverter rating. Since the modulator continues to run, the proper semiconductor switching sequence is reinitiated when they are turned back ON after 200 seconds. If the overcurrent spikes recur, the cycle is repeated, provided the number for current spikes recorded in **IPEAKCOUNT 397** does not exceed eight (8) within 2.4 ms. If Peak value is excessively high, it is diagnosed as a current measurement fault.

The program also measures the peak values of two phases currents and calculates the third phase and determines the peak current imbalance above the frequency limit **BAL-FREQ-LIMIT 290EE**. This maximum value is stored in **Currentbalance 274** in 0.1% of rated current increments.

If the DC overvoltage control is unable to keep bus voltage below 130% of rated, the drive trips on overvoltage (FL06). If the power loss control is unable to keep the bus voltage above 70% of rated, the drive trips on DC undervoltage (FL07).

Power Loss Control

The power loss control circuit holds the inverter in operating condition during short (approximately 0.33 sec or 20 cycles) power failures. The energy required for operation is then taken from the kinetic energy available on the drive shaft. If a power failure lasts longer than one second, the main contactor control logic will not be able to close the contactor any more even if the kinetic energy is sufficient. In that case a backed-up auxiliary voltage should be used for the relay block.

Loss of the supply voltage is indicated in the inverter by a drop in the intermediate circuit voltage and by the loss of the auxiliary voltage in the relay block. This in turn causes the main contactor to open. The intermediate circuit voltage drops typically 15% below the rated value in one millisecond. The supply frequency of the motor is brought down at a rate at which a proper power output is obtained from the motor to keep the intermediate circuit voltage at its reference value. The effect of the moment of inertia J on the drive shaft is set by means of the parameter **JGAIN 81EE**.

Control Operation - When the voltage drops below the limit defined by the parameter **PWDN UCALARM 433EE**, the control is activated. A decrement proportional to the actual torque **IRE FILT** and defined by the parameter **PWDNSLIPGASIN 423 EE** is given to the frequency value. After execution of the decrement, the frequency is integrated downward a rate defined by the parameter **J GAIN 81EE.** Control of the intermediate circuit voltage is of the PD type. The power loss control is always eliminated after a time defined by the parameter **PWDNTIME 430EE**.

Speed Control

The scalar control speed controller uses a tachometer signal to eliminate the error caused in the shaft speed by the slip of the induction motor. The slip is dependent on the load of the motor. The normal speed control operating range is from 5 Hz. to Drivespeedmax. At frequencies below 5 Hz, speed control operates but its control characteristics are slow.

The speed control program includes the following functions:

- Setting the speed reference.
- Speed reference integrator.
- Rounding function of the speed integrator.
- Acceleration compensation.
- PI control.
- Drooping.

When the speed control option is selected it always activates the setting of the speed reference and the speed integrator. The control parameter **CONTROLSEL 71** can be used to switch control on and off at any time.

Figure 4-11 shows the Speed Control diagram.

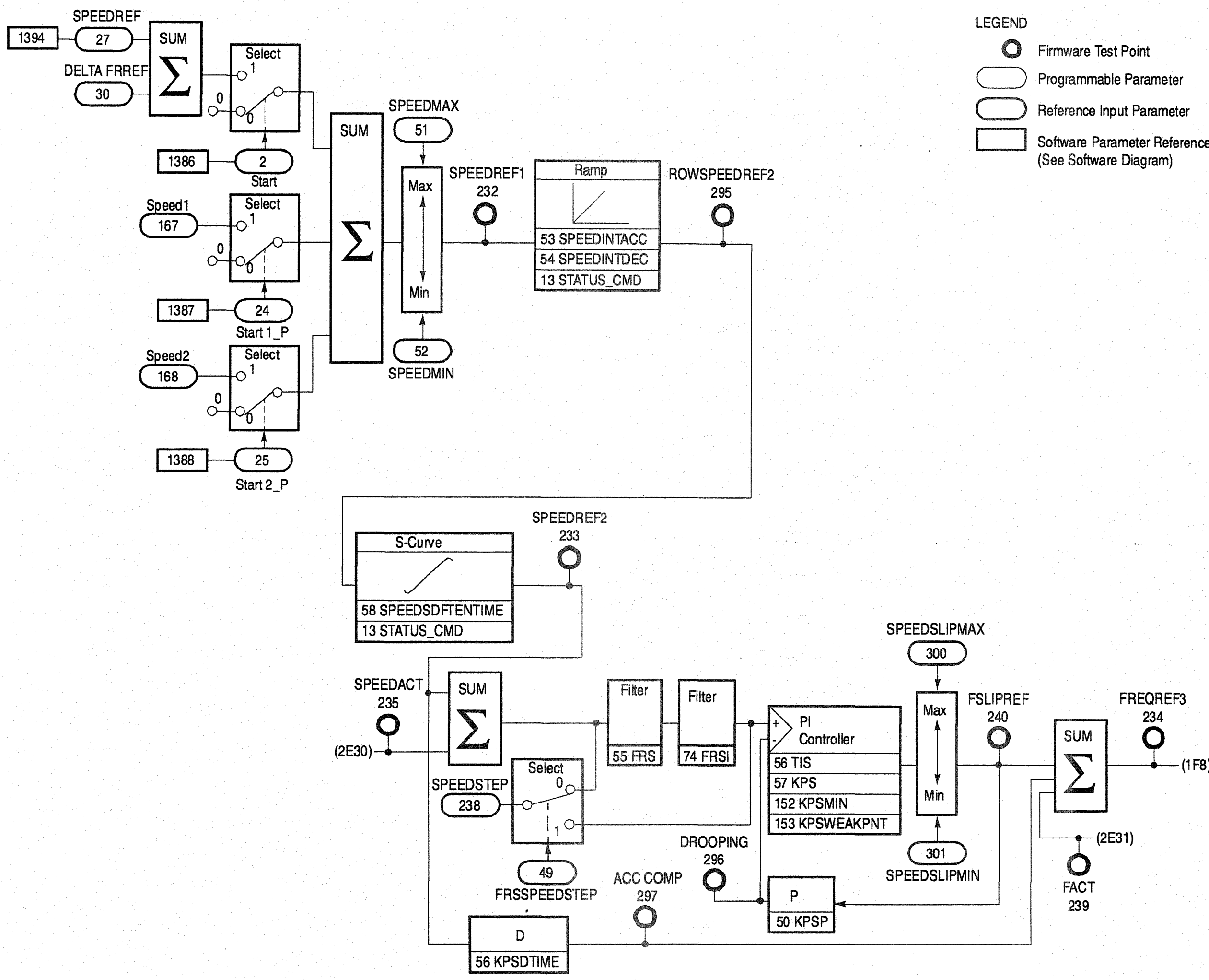


Figure 4-11 Speed Control Block Diagram.

Setting the Speed Reference - The speed reference value can be set as required by the User at three addresses. The speed reference can be sent direct to the communication table location **Speedref 27**. The drive speed accelerates to speed P27 when the start command is given to the address **Start2**.

The communication table contains two memory locations for presetable speed references **Speed1 167EE** and **Speed2 168EE**. These parameters give the reference value when the given start command is **Start1 P24** or **Start2 P25** respectively.

When a value other than zero is sent to the memory location **Stop 3**, the speed reference is set to zero and the drive is stopped by means of a speed integrator. A communication fault can be set to do the same. The selection logic selects one of the four above mentioned speed reference values and sets it to the measuring point **Speedref1 232**. The value limited by **Speedmax 51EE** in the positive direction and by **speedmin 52EE** in the negative direction.

After the limiter, the reference signal passes through the speed integrator and the output obtained in **Rowspedref2 295**. The integrator acceleration and deceleration times are set using parameters **Speedintacc53EE** and **Speedintdec 54EE**.

Rounding Function of the Speed Integrator - Changes occurring in the speed integrator output **Rowspeedref2 295** at the beginning and end of integration can be “softened” by a low-pass filter. The effect of the filter is adjusted by means of the parameter **Speedsoftentime 58EE**. The output obtained is the **Speedref2 233** which is the speed controller reference. Parameter **58EE** gives the duration of the rounding function in units of 0.1s.

Integrator Control in Running Start - In running start, the measured actual speed **Speedact235** is set to the speed integrator output **Rowspeedref2 295** and the measuring point **Speedref2 233**. Integration after start-up towards the reference value then begins at the actual shaft speed of the start-up moment.

Acceleration Compensation - Acceleration compensation may sometimes by necessary during the acceleration storage. The magnitude of acceleration compensation is determined by means of the parameter **KPsdtime 59EE**. The parameter **59EE** gives the time (in seconds) which the process requires to accelerate from 0 speed to 20000 drive speed with a torque requirement equal to the 0.5 Hz slip on the motor time is determined by accelerating the drive when it is under speed control and observing the speed controller output **Fslipref 240**. The magnitude of compensation is correct when, during acceleration, the speed controller output remains approximately at the same level as it would be when running at a constant speed.

The measuring point **ACCCOMP 297** gives the magnitude of compensation in units of 0.01Hz. The compensation is calculated only when the drive is speed controller.

PI Control - The value **SPEEDREF2233** is used as the speed control reference and the **SPEEDACT 235** is the actual speed. The difference between these two speed values can be filtered by means of two consecutive low-pass filters, the filter time constants of which (in milliseconds) are **FRS55EE** and **FRS1 74EE**. The filters are bypassed by setting the time constants to zero.

The proportional gain **KPS57EE** and the integral action parameter **TIS56EE** are the speed control parameters. The controller output produced is a frequency reference which is equal to the motor slip. The output is limited by the positive limit **SPEEDSLIPMAX 300EE** and the negative limit **SPEEDSLIPMIN 301EE**.

Since these parameters limit the motor slip, they also function as current limits. The initialization value for the parameters is 1.5 Hz. If the motor slip exceeds this value the limits must be adjusted equal to the motor slip, otherwise the drive will not give full torque.

The set limits are used in the constant flux range. In the field weakening range, the set limits are increased according to the 1/f characteristic.

The control parameters can be adjusted to some extent to various operating conditions using parameters **KPSMIN 152EE** and **KPSWEAKPNT 156 KPSMIN** is the proportional gain of the controller when the controller is zero. As the controller output increases, the proportional gain changes linearly towards the gain **KPS57EE**. When the controller output exceeds the value of parameter **KPSWEAKPNT 153EE**, the proportional gain is determined by parameter **KPS57EE** only.

Scaling of the controller:

- When KPS=100 and the reference value changes from 0 to 20000, the output changes from 0 to 50 (0.5Hz).
- TIS = integral action time in milliseconds,
- 1000 = 1s.

Drooping - When certain amount of speed decrease caused by the load is to be accepted, a drooping can be set using parameter **KPSP50EE**. The measuring point **DROOPING 296** gives the magnitude of drooping in a unit speed.

Scaling of **KPSP**:

- The decrease of speed in units of 0.1% when the drive operates under maximum load.

Change of the Control Mode

The scalar control program includes three control mode options: frequency, speed or torque control. Selection of speed and torque control requires that the appropriate option be activated at the factory and the selection flag be set. Change of the control mode is made by means of the parameter

CONTROLSEL 71EE:

- 71EE = 0 frequency control
- 71EE = 1 speed control
- 71EE = 2 torque control

Change from one control mode to another can be made whenever required. At frequencies below 5 Hz and when a STOP command is given, torque control is automatically changed to frequency control.

Torque Control

The inputs to the Torque PI Control are **TORQREF 26** (torque reference) and **T-ACT202** (torque feedback). The Proportional Gain is **KPTORQUE 390** and the Integral Gain is **TI-TORQUE 391**. The torque reference and feedback values are scaled so that 1000 equals rated motor torque. The output is **TORQCONTOUT379** and is scaled so that 100 = 1 Hz. **TORQCONTOUT** is added to the absolute value of the frequency and when selected (**CONTROLSEL 71**=2), becomes the frequency reference to the modulator.

When the stop command is received, the program is switched from torque control to frequency control. Anytime the frequency is below 5 Hz, the program resets **CONTROLSEL 71** to 0 which selects frequency control; therefore, minimum frequency should be set to 5 Hz. minimum. Stall protection is provided as standard when Torque Control is ordered.

STX Start of text character

ADDR Address consisting of 2-ASCII characters representing address number in Hex.

DATA Data consisting of 4-ASCII characters representing the data value in Hex.

CR Carriage return

DCC Block Check Character - a number representing the binary sum of the message bits.

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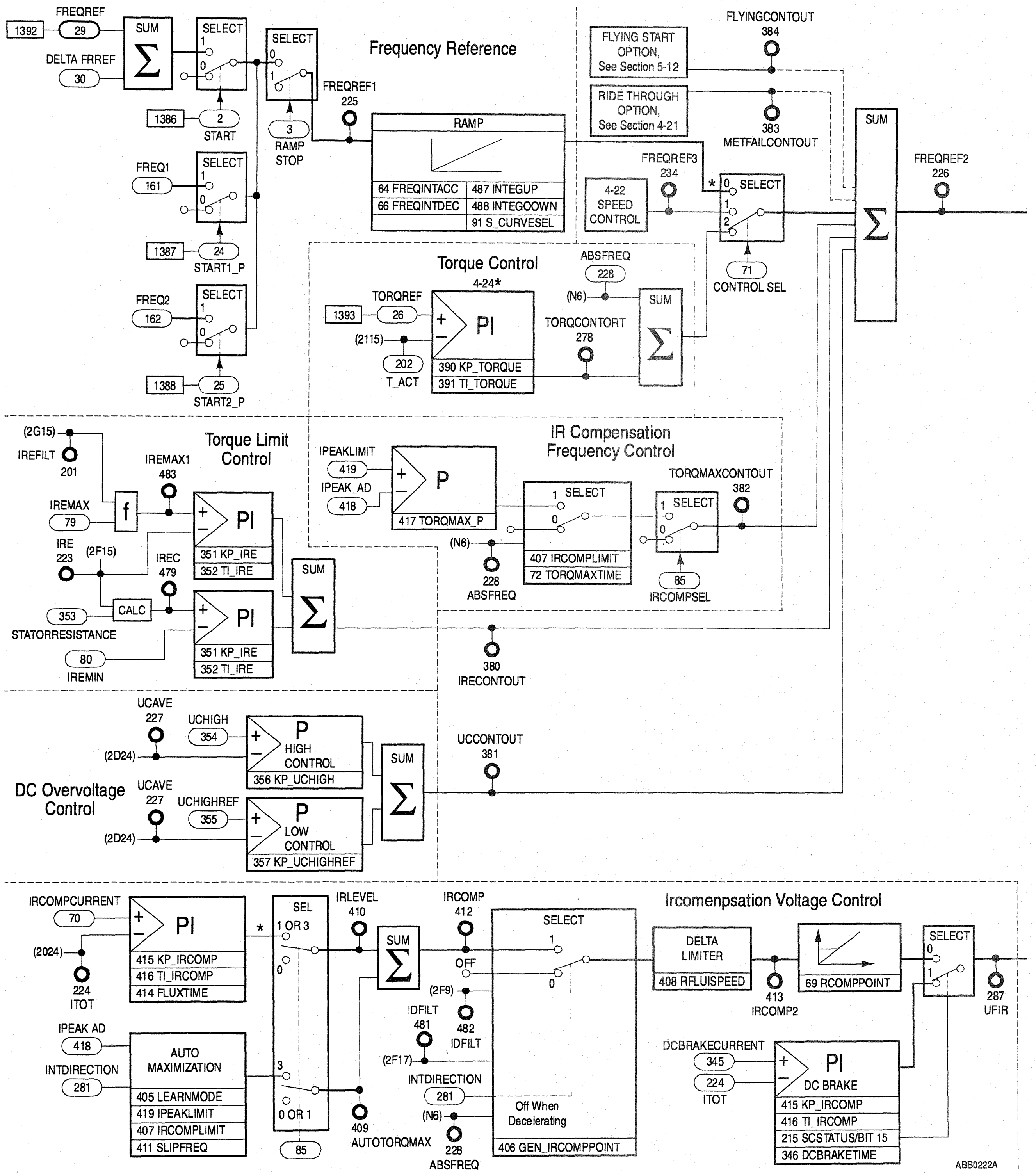
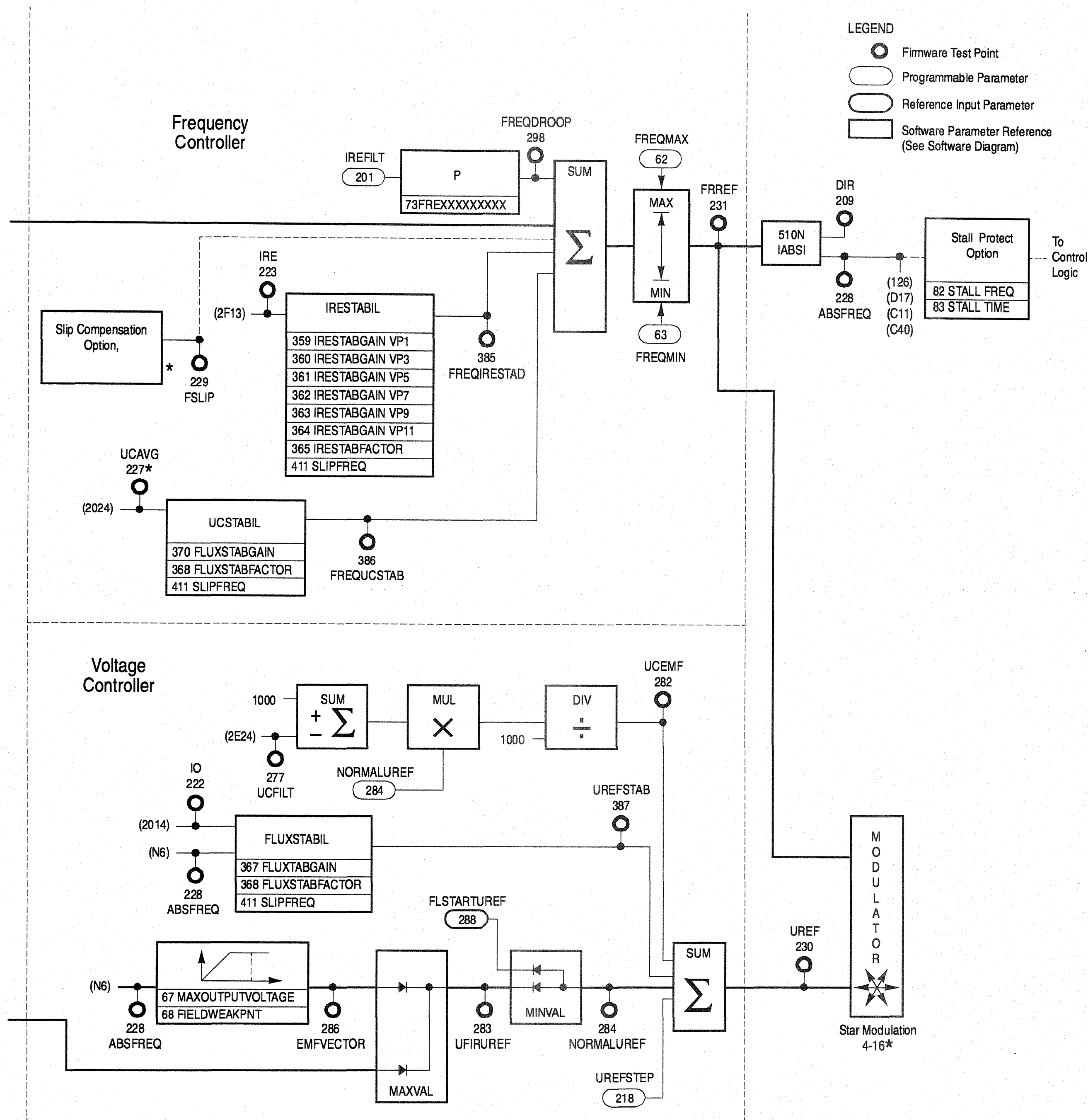


Figure 4-12 Software Block Diagram


LEGEND
Firmware Test Point
Programmable Parameter
Reference Input Parameter
Software Parameter Reference (See Software Diagram)
Frequency Controller
IREFILT
201
P
73FREXXXXXXXXX
FREQDROOP
298
SUM
FREQMAX
62
MAX
MIN
63
FREQMIN
FRREF
231
510N
IABSI
DIR
209
228
ABSFREQ
(126)
(D17)
(C11)
(C40)
Stall Protect Option
82 STALL FREQ
83 STALL TIME
To Control Logic
IRE
223
(2F13)
IRESTABIL
359 IRESTABGAIN VP1
360 IRESTABGAIN VP3
361 IRESTABGAIN VP5
362 IRESTABGAIN VP7
363 IRESTABGAIN VP9
364 IRESTABGAIN VP11
365 IRESTABFACTOR
411 SLIPFREQ
385
FREQIRESTAD
Slip Compensation Option,
*
229
FSLIP
UCAVG
227*
(2024)
UCSTABIL
370 FLUXSTABGAIN
368 FLUXSTABFACTOR
411 SLIPFREQ
386
FREQUCSTAB
Voltage Controller
1000
SUM
(2E24)
277
UCFILT
MUL
NORMALUREF
284
1000
DIV
UCEMF
282
IO
222
(2014)
(N6)
228
ABSFREQ
FLUXSTABIL
367 FLUXTABGAIN
368 FLUXSTABFACTOR
411 SLIPFREQ
UREFSTAB
387
FLSTARTUREF
288
(N6)
67 MAXOUTPUTVOLTAGE
68 FIELDWEAKPNT
228
ABSFREQ
286
EMFVECTOR
MAXVAL
283
UFIRUREF
MINVAL
284
NORMALUREF
UREFSTEP
218
SUM
UREF
230
M O D U L A T O R
Star Modulation 4-16*

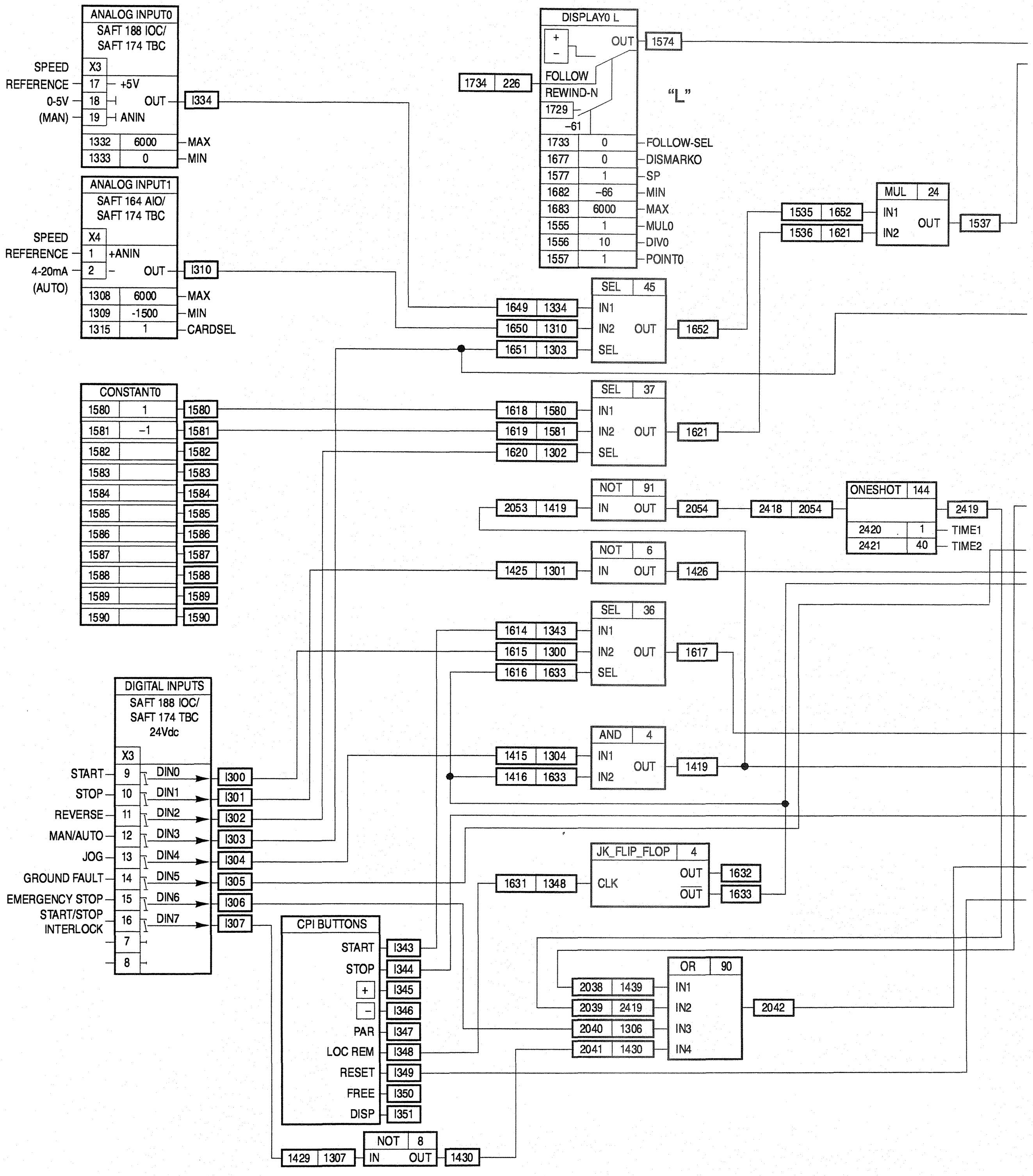
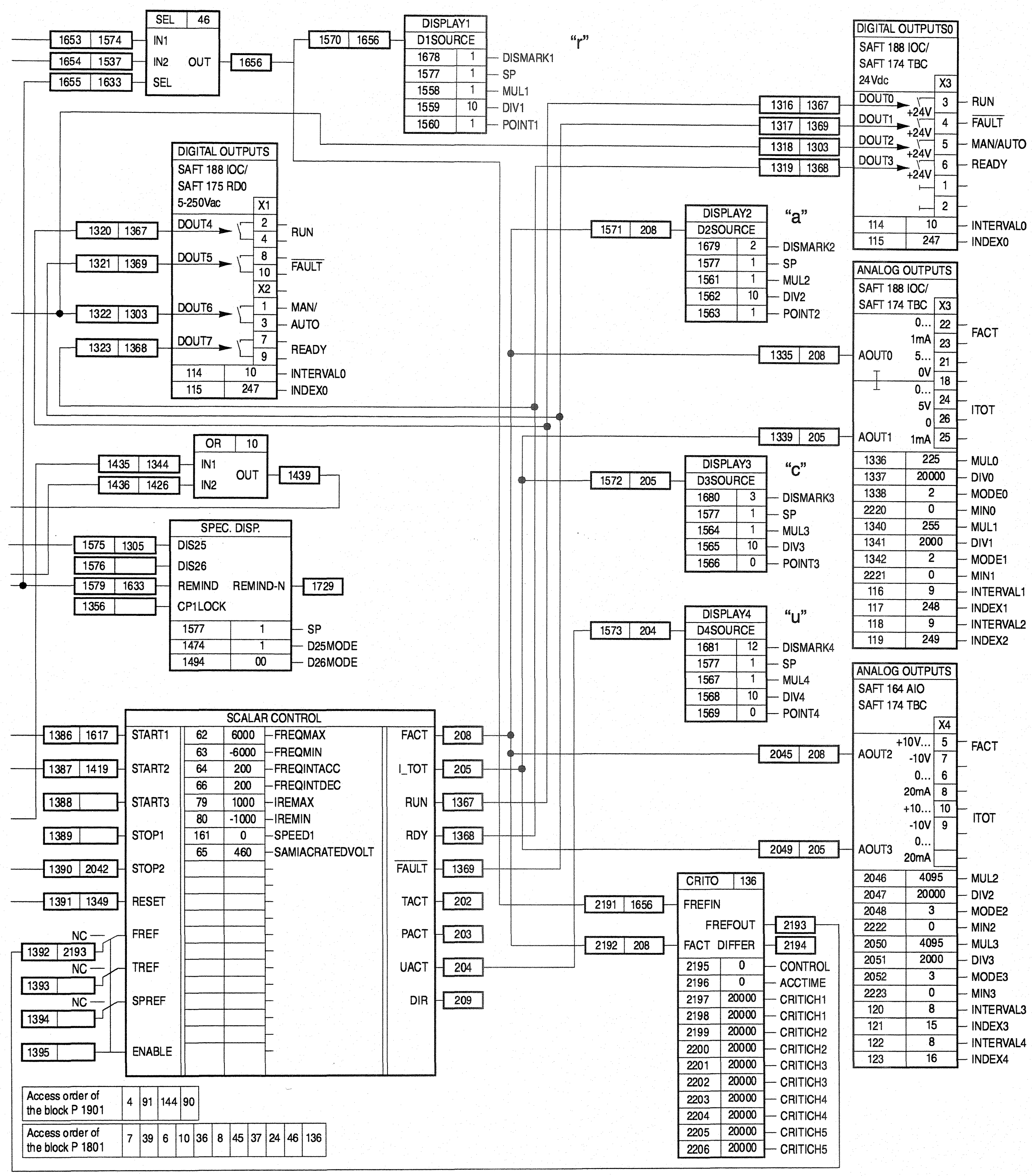


Figure 4-13 Standard Scalar Software Diagram



SEL 46
IN1
IN2 OUT
SEL
1653 1574
1654 1537
1655 1633
1656
1570 1656
DISPLAY1
D1SOURCE
1678 1 DISMARK1
1577 1 SP
1558 1 MUL1
1559 10 DIV1
1560 1 POINT1
"r"
DIGITAL OUTPUTS
SAFT 188 IOC/
SAFT 175 RD0
5-250Vac
X1
1320 1367 DOUT4 2 4 RUN
1321 1369 DOUT5 8 10 FAULT
X2
1322 1303 DOUT6 1 MAN/ 3 AUTO
1323 1368 DOUT7 7 9 READY
114 10 INTERVAL0
115 247 INDEX0
DIGITAL OUTPUTS0
SAFT 188 IOC/
SAFT 174 TBC
24Vdc
X3
1316 1367 DOUT0 +24V 3 RUN
1317 1369 DOUT1 +24V 4 FAULT
1318 1303 DOUT2 +24V 5 MAN/AUTO
1319 1368 DOUT3 +24V 6 READY
1
2
114 10 INTERVAL0
115 247 INDEX0
1571 208
DISPLAY2
D2SOURCE
1679 2 DISMARK2
1577 1 SP
1561 1 MUL2
1562 10 DIV2
1563 1 POINT2
"a"
ANALOG OUTPUTS
SAFT 188 IOC/
SAFT 174 TBC
X3
1335 208 AOUT0
0... 22 FACT
1mA 23
5... 21
0V 18
0... 24 ITOT
5V 26
0 25
1339 205 AOUT1 1mA
1336 225 MUL0
1337 20000 DIV0
1338 2 MODE0
2220 0 MIN0
1340 255 MUL1
1341 2000 DIV1
1342 2 MODE1
2221 0 MIN1
116 9 INTERVAL1
117 248 INDEX1
118 9 INTERVAL2
119 249 INDEX2
OR 10
IN1
IN2 OUT
1435 1344
1436 1426
1439
1572 205
DISPLAY3
D3SOURCE
1680 3 DISMARK3
1577 1 SP
1564 1 MUL3
1565 10 DIV3
1566 0 POINT3
"c"
SPEC. DISP.
1575 1305 DIS25
1576 DIS26
1579 1633 REMIND REMIND-N 1729
1356 CP1LOCK
1577 1 SP
1474 1 D25MODE
1494 00 D26MODE
1573 204
DISPLAY4
D4SOURCE
1681 12 DISMARK4
1577 1 SP
1567 1 MUL4
1568 10 DIV4
1569 0 POINT4
"u"
ANALOG OUTPUTS
SAFT 164 AIO
SAFT 174 TBC
X4
2045 208 AOUT2
+10V... 5 FACT
-10V 7
0... 6
20mA 8
+10... 10 ITOT
-10V 9
2049 205 AOUT3
0... 20mA
2046 4095 MUL2
2047 20000 DIV2
2048 3 MODE2
2222 0 MIN2
2050 4095 MUL3
2051 2000 DIV3
2052 3 MODE3
2223 0 MIN3
120 8 INTERVAL3
121 15 INDEX3
122 8 INTERVAL4
123 16 INDEX4
SCALAR CONTROL
1386 1617 START1
1387 1419 START2
1388 START3
1389 STOP1
1390 2042 STOP2
1391 1349 RESET
NC
1392 2193 FREF
NC
1393 TREF
NC
1394 SPREF
1395 ENABLE
62 6000 FREQMAX
63 -6000 FREQMIN
64 200 FREQINTACC
66 200 FREQINTDEC
79 1000 IREMAX
80 -1000 IREMIN
161 0 SPEED1
65 460 SAMIACRATEDVOLT
FACT 208
I_TOT 205
RUN 1367
RDY 1368
FAULT 1369
TACT 202
PACT 203
UACT 204
DIR 209
CRITO 136
2191 1656 FREFIN
FREFOUT 2193
2192 208 FACT DIFFER 2194
2195 0 CONTROL
2196 0 ACCTIME
2197 20000 CRITICH1
2198 20000 CRITICH1
2199 20000 CRITICH2
2200 20000 CRITICH2
2201 20000 CRITICH3
2202 20000 CRITICH3
2203 20000 CRITICH4
2204 20000 CRITICH4
2205 20000 CRITICH5
2206 20000 CRITICH5
Access order of the block P 1901 4 91 144 90
Access order of the block P 1801 7 39 6 10 36 8 45 37 24 46 136

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Chapter 5 – Start-Up

General Instructions

These instructions are for use only by qualified personnel trained by ABB Industrial Systems Inc. on the use of this equipment. The safety precautions outlines in this Section 1-6 must be adhered to at all times. In addition, the following must be noted before beginning any start-up adjustments or performing any maintenance on the SAMISTAR Drive:

- The inverter should always be treated as though it carries live voltage, until verified to be voltage free by measurement.
- All control cards and power bridge components are at DC bus potential except for the I/O cards, which are galvanically isolated by the fiber optic link to the control card.

WARNING: When voltage is supplied to the inverter, a potentially fatal voltage is present between the cards and the inverter chassis! Only qualified service personnel familiar with the SAMISTAR Drive should attempt the start-up.

- The inverter should be checked at both the + and - connectors and at the DC rectifier bus bar of the line supply unit to ensure absence of voltage.
- A final check should be made to ensure that the control voltage AC circuits are voltage free.

Site Preparation

The following preparations should be made prior to beginning the start-up.

- Clean the work area of any foreign objects or obstructions.
- Provide proper lighting of the work area.
- Set up tables or clear a workbench surface for drawings and test equipment.
- Locate power supplies for test equipment.
- Secure Start-up work area and rope off as required.

Preparation for Start-Up

The following preparations should be made prior to beginning the start-up:

- Familiarize yourself with the start-up sequence shown in the block diagram, Figure 2-1.
- Familiarize yourself with the operation of the Control Panel (CP1) operator interface and display and familiarize yourself with the operation of the DMS if available.

- Inspect the installation. For proper environmental conditions see Chapter 3.
- Review the schematics for the Drive to ensure that the control wires are correctly installed and provide the intended operator control sequence.
- Review and set switch and jumper settings as detailed in Chapter 2.

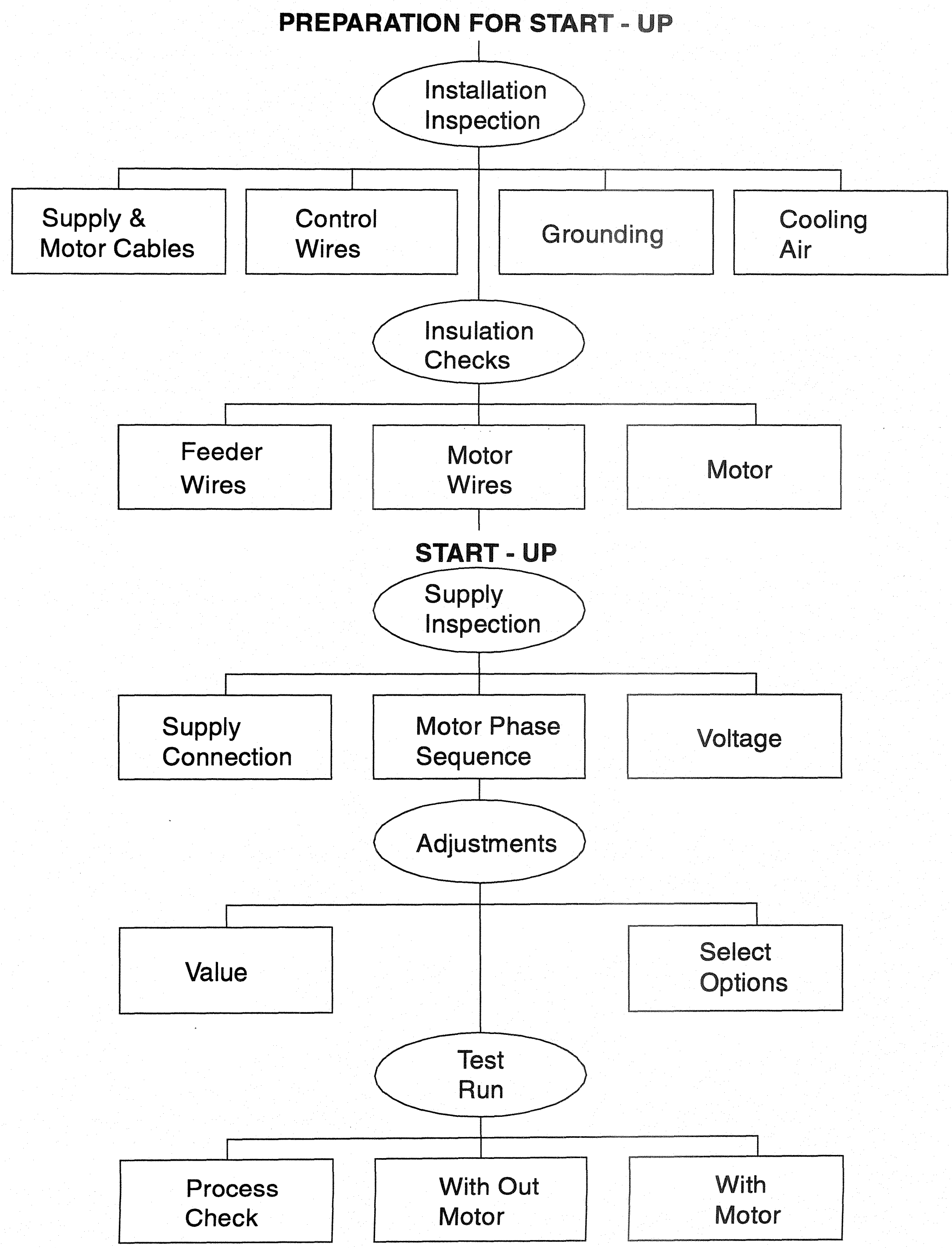

Figure 5-1 Start-Up Sequence

Installation Inspection

Before beginning any start-up procedures, check to see that the Drive is correctly mounted and wired, as detailed in Chapter 3. Particular attention should be paid to the following:

- Inspect components inside the equipment for shipping damage. If broken components are found, they may be ordered early in the checkout process. Damaged components must be replace before energizing equipment.
- Supply and output cables are the correct size and type and that supply cables are protected against overloads or short circuit by correctly sized fuses. It is recommended that the wires running from the drive to the motor be not smaller than those used for the main voltage source connections to the drive. This provides protection against overheating caused by harmonic currents, and it allows bypass devices to be added at a future date.
- Shielded cables have been used for control circuits to provide interference protection.
- Check that all shielded cables are routed properly. Shielded cables should NOT be run parallel to any POWER cables, CONTROL cables (PLC I/O, 120V AC circuits, power supplies, etc.), or PULSE circuit cables. If SHORT parallel runs are necessary, they should be separated by at least 6 inches, from any of the above mentioned wiring. It is a good practice to have the electricians route shielded cables down one side of the cabinet, and all other cables, on the opposite side. Control cable should be run in steel conduit.
- Investigate system grounding. Check that ALL motors are grounded. Trace signal common cabling and verify that it is separated from any PE grounds (earth ground). Check that ANY shielded cables are terminated at ONLY one end.
- The cabinet has sufficient clearance to allow unobstructed air flow through the vents. Check for correct cooling fan operation and properly conditioned air that meets the requirements in Chapter 3.
- All packing material, wedges or braces have been removed from inside the controller. Operate the contactors and relays manually to ensure they operate freely, before applying any power to the cabinet.

CAUTION: Contactors are often shipped with the contacts blocked closed. If blocking material is not properly removed, main fuses could open upon energization.

- Check that NO foreign objects are present in the equipment. (shielded cable foil, metal filings, tools, etc.) Vacuum out cabinets if necessary.
- Verify that ALL INTERNAL & ALL CONTRACTOR wiring connections are tight (tug test).

- Check that all interconnecting wires are tagged properly.
- Verify with ohmmeter, that ALL contacator installed wiring, has been installed per ABB's latest schematic. In addition to reducing part failures due to miss-wiring, this step can easily find missing wires which can be pulled before start-up deadlines have been reached.

Verify that any motors are:

1. Tightly bolted down.
2. Properly grounded.
3. Properly terminated with tight connections.
4. All covers are in place.
5. Uncoupled - coupling must be secure. If no coupling is present remove key from shaft.

Perform the following:

1. Verify correct tachometer wiring and pulse number.
2. Complete "Motor Data Sheet" with ALL information.
3. Check if auxiliary motor ventilation blower is turning in the correct direction.

- Have maintenance representative rope/flag off drive and motor areas to keep non-authorized people away. Several different contractors may have been working on the drives, motors and connected equipment well before equipment energization. It may not occur to them that the equipment will soon be RUNNING and that SAFETY HAZARDS WILL EXIST.
- In preparation for energization, temporarily disconnect the communication cable from remote controls. This is to ensure that no unexplained inverter motor operation occurs due to automatic program operation.
- Verify that drive is set up for the proper incoming AC power values (220, 460, 575, 600 VAC).
- Install temporary Emergency Stop switch(es) into the Coast-Stop circuit of drive. The Emergency switch(es) must be in reach of a responsible person(s) who can sense if damage is present either at the motor or at the drive cabinet itself (motor runaway, drive cabinet fire, etc).

Insulation Checks

Before beginning the insulation checks, the following steps must be taken:

- Open the main disconnect switch.
- Remove the main fuses, F1, F2 and F3.
- Disconnect motor wires from Drive output U2, V2, W2.

WARNING: A possible shock hazard exists due to residual charges on the DC Bus Capacitors. DO NOT touch any drive components until zero volts has been measured at the "+" and "-" DC bus and the rectifier bus bar.

- Measure the motor and cable insulation as follows with an instrument using a voltage at least equal to the voltage rating of the Drive; however, DO NOT exceed 1000V.

CAUTION: Do not megger or high pot the Inverter Unit, because high voltage can damage semiconductors.

- Check with an ohmmeter, that no short circuits or grounds exist between input phases or output conductors of the drive's power section.
- Measure the insulation of the supply wires between phases (L1-L2, L2-L3, L3-L1) and between each phase and the ground or neutral conductor, if present.
- Measure the insulation of the motor wires between phases and between each phase and the ground.
- Measure the insulation of the motor between phases and between each phase and the motor frame.

The insulation resistance must be greater than 1 Megohm in each case. Note the values for each measuring point and record this data in the start-up record.

Power on Checks

Initially it is recommended that the control power be applied to the drive with the DC bus at zero potential!! The main control circuits can then be verified for functionality before allowing the inverter section to operate. Remove jumper or open switch between terminals TB1-15 and TB1-16 see Figure 5-2 to disable DC bus.

- With main disconnect open, install fuses F1, F2 and F3 Figure 5-2.

IMPORTANT: *Do not connect the motor wires U2, V2 or W2 to the output of the Drive at this time.*

- Measure and second the incoming supply voltage at terminals L1, L2, L3 to assure all phases exhibit correct voltage (nominal phase-to-phase voltage, +10%).
- Turn on Main Disconnect.

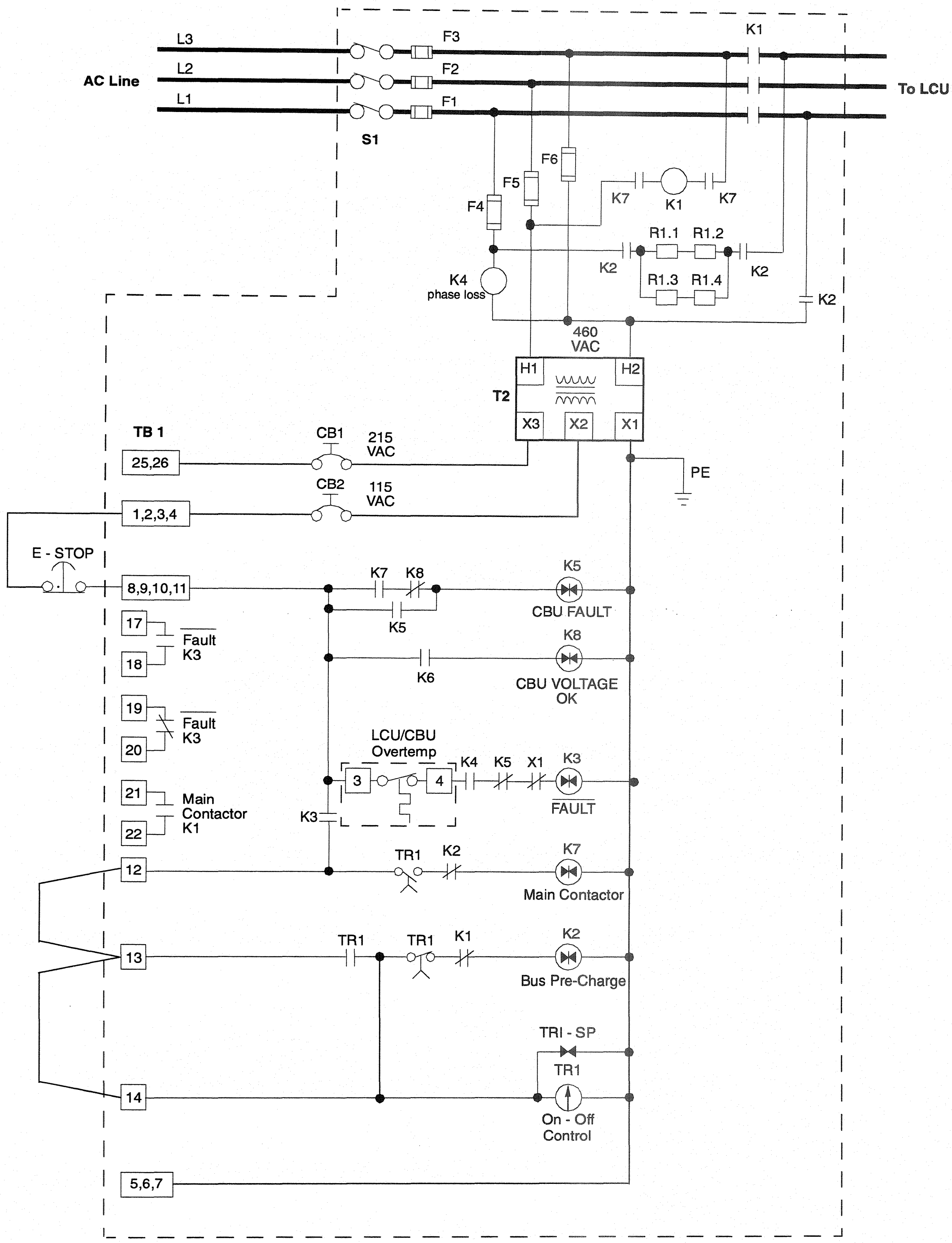

Figure 5-2 Typical Contactor Unit Logic

Measure and Record the control power voltage present on the TB1 Terminal Strip as follows:

Terminal	Voltage
1 to 25	115
6 to 25	215

Check with an oscilloscope and meter that control power supplies are the proper levels and frequencies (+ 14V DC, + 5V DC, 42V AC @ 80kHz).

- On 210kVA and larger units, check that the circuit breaker F51 located at the bottom of the LCU is turned ON. This breaker interrupts the power to the LCU & CBU cooling fans.
- Check that the circuit breaker interrupting the power to the INU cooling fans is turned ON. (F2 on GTR units, F11 on GTO units).

Verify that all visual indicators of drive status are properly lit:

1. Red LED on Control Board.
2. Green LED on Power Supply Board.
3. Green LED on Chopper Control Board.
4. Green LED's on each Pulse Amplifier/Base Driver Board.

Connect DMS computer or CP2 control panel to drive or verify operation of CPI.

- With CP1, CP2, or DMS computer, establish communications to drive and check for faults and proper control card power-up.

IMPORTANT: *Drive can be started to further check out inverter without energizing DC bus by setting jumpers on power supply cards for simulation mode. See hardware section of manual for jumper settings.*

Energization of DC Bus (start-up of LSU)

Since there are two basic types of Drive configurations, (common DC bus or individual Drive), there are also two methods of supplying energy to the DC bus. This section deals only with start-up of the individual Drive.

IMPORTANT: *If the Drive application uses a common DC bus, refer to the start-up section in the SAMI STAR System Manual.*

Move the Main Disconnect Switch (S2) to the OFF position. Reconnect the jumper between terminals TB1-15 and TB1-16 or close the switch connecting these terminals.

WARNING: If bus voltage simulate was used, return power supply jumpers to their normal run position before applying power to drive.

Move the Main Disconnect Switch (S1) to the ON position. Within 0.5 seconds, the DC bus will be charged and the main contactor will close. The control panel will illuminate and the cooling fans will start.

Scalar Control Firmware Versions

Verify the software version of EPROM memory circuits D17 and D18 on the Main Control Card SAFT 187CON. These must be version SAFRSC 4.04.

Channel 1 Baud rate is set with jumper S2 on the Main Control Card SAFT 187CON. A-C for 4800 Baud and A-B for 9600 Baud. Channel 2 Baud rate is set from 110 to 9600 Baud with parameter 170EE. The SAFT 188 IOC auto baud selects on channel 1 and the 3500 TBX auto baud selects on either channel connected to it. Channel 2 Baud rate must be set the same as the DMS software or control panel connected to it.

Note: Changes to Channel 2 Baud rate must be saved to EEPROM, and then control power cycled before it will take effect.

Equipment Recommended

An accurate voltmeter, capable of safely measuring up to 1000 volts AC or DC, will be needed for measurement and verification of voltage in the Drive cabinet.

WARNING: Many of the circuit cards are linked to the DC bus voltage. Exercise extreme caution when performing any of the procedures in this instruction. NEVER WORK ALONE!

Combinations of three possible hardware configurations exist when interfacing with the Drive parameter table:

1. Drive Maintenance System (DMS) program and computer to Drive interface hardware:

IMPORTANT: *Refer to the DMS 7000 User Manual for Drive Maintenance System connection and operation.*

---

2. CP5 Remote Control Panel, 4 channel A/D converter SAFT154DAC and a chart recorder on an oscilloscope.
3. CP1 Standard Control Panel on single Drives.

Start-Up Procedures

The start-up of the Drive is completed in various steps. Each step is important in this procedure and cannot be omitted. The steps are dependent on each other and the correct entry and calculation of data from all previous steps. Incorrect or invalid information will most likely cause errors and difficulties may arise when Drive operation is attempted.

Work Carefully

The first steps of the instruction require checking and recording of the nameplate data from the Drive inverter unit and motor nameplates. This information is very important for the successful completion of the start-up procedure. Record this information on the AC motor data sheet.

After the microprocessor has calculated other values from the input information, the instructions will ask that the results of these calculations be verified manually. This serves as verification that the data initially entered was legitimate, both in value and format. As the examples will show, the data format may not be immediately obvious. Proceed carefully in all these steps.

Safety Concerns

Several of the later steps require that the motor, Drive and finally the equipment be properly prepared to operate up to at least half speed. Safety for personnel and equipment now becomes the primary concern. A means of shutting down the Drive is required in the event of trouble. These preparations need to be completed before these steps in the start-up instructions are attempted. Proper motor mounting, wiring and lubrication all need to be verified prior to this step.

Personnel working in the area must be alerted to the dangers of the equipment operations being attempted.

IMPORTANT: *The procedures contained herein are written to aid in the successful start-up of the Drive. There remains no substitute for good common sense judgment and cautious working methods on the part of the personnel using this procedure. If any part of this instruction seems confusing or contradictory to safe practices, contact your area ABB Drives Sales representative for clarification or assistance.*

The SAMISTAR shipped with standard function block software as shown in Figure 5-4. Figure 5-4 is a reference key for function blocks shown in this section

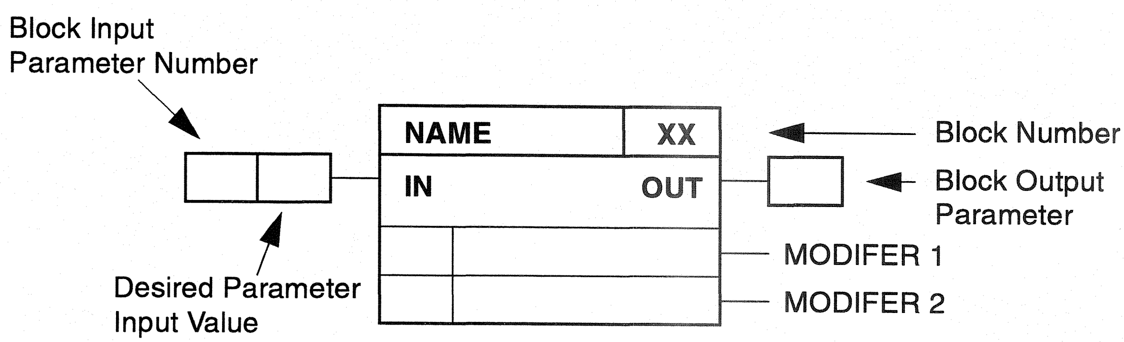

Figure 5-3 Drawing Reference Key

Step 1: Information Recording and Entry

Recording information from the motor and the inverter.

Inverter Information:

Read and record the information from the Inverter Matching Card (small card located on the Control Card SAFT 187 CON).

i.e. "290F460" means 290 kVA, 460Volts.

- Inverter rated voltage INU volts (Volts).
- Inverter rated power INU kVA (kVA).

Motor Information:

Read and record the nameplate information from the motor:

- Motor rated voltage: ACRated (Volts).
- Motor rated frequency: FRated (Hz).
- Motor rated current: FLARated (Amps).
- Motor rated power factor: Power Factor Cos (phi).
- Motor rated speed: RPMRated.

1. Verify that the motor is connected correctly for that rated voltage (delta or wye connection).
2. If the power factor cannot be determined from the nameplate, the following values can be used:

Table 5-3 Sample Motor Power Factor Values

Motor RPM	Power Factors
1800 to 3600	0.90
1200 to 1800	0.86
900 to 1200	0.80
750 to 900	0.78
600 to 750	0.75

Table 5-4 Inverter Amperage Ratings

Inverter KVA Volts	Inverter Amps	Inverter KVA Volts	Inverter Amps
30 @ 460	37	110 @ 575	110
50 @ 460	63	140 @ 575	140
75 @ 460	94	210 @ 575	210
100 @ 460	126	280 @ 575	280
115 @ 460	144	340 @ 575	340
150 @ 460	188	440 @ 575	440
180 @ 460	226	540 @ 575	540
230 @ 460	290	700 @ 575	700
290 @ 460	360	870 @ 575	870
370 @ 460	465		
460 @ 460	580		
580@ 460	730		
730 @ 460	920		

Enter the appropriated motor and inverter nameplate information.

Table 5-5 Drive and Motor Information Records

Nameplate Data		Drive Parameter	Actual Values
INU_{VOLTS} (Volts)		65EE SAMI_AC_RATED VOLTAGE	
INU_{kVA} (kVA)			
INU_{AMPS} (Amps)		2001EE	
AC_{RATED} (Volts)			
F_{RATED} (HZ)		68EE FIELDWEAKPT	
FLA_{RATED} (Amps)		2000EE	
Power Factor (cosphi)		1547EE	
RPM_{RATED}			

Step 2: Drive Tuning Adjustments

The SAMISTAR does not use potentiometers to set the reference values and other parameters.These are set using parameters, which are memory locations where a value is stored. Most parameters store a number that is related to the function such as Parameter 29 (Frequency Reference) which is scaled in 0.01 Hz so that a value of 6000 equals 60 Hz

There are several functions which may require adjustment during start-up. All except IR Compensation can be done with the motor disconnected.

The adjustments are:

1. Total Current Limit
2. Preset Frequency Reference
3. Accel/Decel Rates
4. "S" Curve Ramp
5. Minimum/Maximum Speed
6. Analog Input Scaling
7. Analog Output Scaling
8. IR Compensation

   NOTE: Refer to Chapter 6 for instructions on the operation of Local Control Panel (CP1) or DMS to enable tuning parameters.

Parameter Data Entry - The values in Example Table 5-6 are from example motor and inverter nameplate. These values need to be entered in the parameter table of the Drive in this step. Be careful to enter all data correctly in the parameter. An error at this step will result in improper Drive calibration and the Drive will not function properly. Example VALUES shows corresponding parameter values that are converted to Drive units for entry.

Table 5-6 Sample Values from the motor and inverter nameplates.

Nameplate Data		**Drive Parameter**	**Actual Values**
INU_{VOLTS} (Volts)	460	65EE SAMI_AC_RATED VOLTAGE	460
INU_{kVA} (kVA)	290	NOT USED IN SCALAR	--
INU_{AMPS} (Amps)	360	2001EE	3590
AC_{RATED} (Volts)	460	NOT USED IN SCALAR	--
F_{RATED} (HZ)	60	68EE FIELDWEAKPT	6000
FLA_{RATED} (Amps)	173	2000EE	1730
Power Factor (cosphi)	0.89	1547EE	890
RPM_{RATED}	1785	NOT USED IN SCALAR	--

Step 3: Preliminary Parameter Settings

In preparation for the next step of the start-up procedure, the parameter values in Table 5-9 should be checked. The table gives temporary settings for some parameters that will allow the start-up to continue more smoothly.

Table 5-7 Preliminary Settings for Start-up/Check-out Steps

Parameter Name	Parameter Number	Set-up Value
SCALARCONTROL	48EE	1
FREQMAX	62EE	6000
FREQMIN	63EE	-6000
FREQINTACC	64EE	200
FREQINTDEC	66EE	200
MAXOUTPUTVOLTAGE	67EE	100
FIELDWEAKPNT	68EE	6000
IRCOMPPOINT	69EE	3000
IRCOMPCURRENT	70EE	0
CONTROLSEL	71EE	0
TORQMAXTIME	72EE	0
FREQDROOPING	73EE	0
RESTARTDELAY	75EE	3000
STOPFREQ	77EE	100
IRCOMPSEL	85EE	1
COMM_TIMEOUT2	157EE	0
CHARGETIME	158EE	6
FREQ1	161EE	1000
FREQ2	162EE	-1000
SCDRIVETYPE	166EE	0
CH2BAUDRATE	170EE	DMS BAUD RATE
SELMACONT	171EE	S/B 0
COMM_TIMEOUT	172EE	238
E_S_LIMIT	275EE	100
*DRIVE CURRENT LIMIT	2003EE	500

* or reduce 79EE to 1/2 calculated value if setting directly.

Analog Input Scaling

The standard Drive is shipped with the analog input scaling set for a 4 to 20mA signal equal to 0 to 60 Hz output. The Drive however, has the flexibility to accept many other inputs scale various ways. Ensure all hardware jumpers are in the proper position for current or voltage input as described in chapter 2.

Table 5-8 Analog Input Scaling

Input Source	Drive Frequency Hz		Analog Input		Multiplier	Offset
mAmps Volts	**Min. 63EE**	**Max. 62EE**	**Min. 1333EE 1671EE**	**1332EE 1672EE**	**1755EE**	**2002EE**
4-20	0	60	-1500	6000	+1	0
-10>+10	-60	+60	-6000	6000	+1	0

IMPORTANT: *Be sure to document any changes you make for later reference. These values are only temporary and some may need to be reset to their original values when the start-up is nearly complete.*

Remember to save new values to EEPROM by setting parameter T8 value to "1" for 1 minute. Reset to "0" after 1 minute.

Table 5-9 Additional settings for start-up/check-out steps with firmware Version SAFRSC 4.04

Parameter Name	Parameter Number	Set-up Values
**** FREF_SCLR	1392EE	29
**** TREF_SCLR	1393EE	26
**** SPREF_SCLR	1394EE	27
**** ENABLE	1395EE	27

**** These parameters are only used for initial start-up of firmware version SAFRSC 4.04 Scalar Control. Record original values for future reference.

Step 4: Feedback Signal Checks

Calibration of the DC Bus Voltage Measurement.

IMPORTANT: *If you use DMS, remember to press the INS key to read the current value of these parameters.*

---

1. With the DC bus charged, carefully measure the DC voltage between the + and - bus bars at the tope of the inverter unit.
2. Enter the measured value into parameter 258EE UCMEASURED _ON_BUS in volts.
3. Set the value of parameter 260 FIND UC OFFSET to "1".
4. After parameter 260 is set to 1, re-check the value of 257 UCVOLTAGE which should be automatically corrected to the value you entered into parameter 258EE UCMEASURED ON BUS.
5. Parameter 260 will reset itself to zero after calibration is completed.
6. The new offset computed by the calibration program will appear in parameter 261EE UCOFFSET.
7. If the value of 257 UCVOLTAGE still isn't the same as the value measured from the DC bus (+10) or if parameter 260 doesn't automatically reset to zero, proceed to APPENDIX NO3 (DC-voltage measurement hardware).

Remember to save new values to EEPROM by setting parameter 8 value to "1" for 1 minute. Reset to "0" after 1 minute.

Calibration of the Current Measurement.

WARNING: The Control Card circuits are linked to the DC bus voltage. Exercise extreme caution when performing work in the following procedure.

IMPORTANT: If you use DMS, consult the DMS User's Manual for proper operation.

IMPORTANT: *The largest current measurement error the program can self-correct is +5%. Further adjustment may be necessary.*

---

1. Set the value of parameter 190EE CURRENTOFFSET to zero.
2. If the value of parameters '219 IR' or '220 IS' is within +10, it is not necessary to perform the following potentiometer calibrations. Set parameter 190EE value back to "to" and continue with Section 5-8.
3. If the values of parameters '219 IR' or '220 IS' are not within +10, the following adjustments are needed:
   - adjust potentiometer R12 on the Main Control Card SAFT 187 CON until parameter 219 as close to zero as possible.
   - adjust potentiometer R13 on the Main Control Card SAFT 187 CON until parameter 220 as close to zero as possible.
   - reset the value of parameter 190EE CURRENTOFFSET to "50".

Remember to save new values to EEPROM by setting parameter 8 value to "1" for 1 minute. Reset to "0" after 1 minute.

Step 5: Starting the Drive and Motor Rotation Checks

Running Uncoupled Checking Motor Rotation.

1. This step requires that the motor shaft be uncoupled from the load and that personnel in the area be warned of the danger of the motor shaft rotating.
2. Check that the motor is securely mounted and fully prepared for operation. Verify that the bearings have lubrication and that there is no mechanical interference when the shaft is rotated by hand.
3. Locate hard-wired COAST-STOP buttons at appropriate places, (at motor, by tending side of machine, by CP1 or DMS computer).

IMPORTANT: *After the Drive has been energized, test each Coast-Stop button for functionality.*

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4. Arrange for maintenance representative, with radio communications, to watch equipment and to keep in contact with the person(s) about to tune the equipment.
5. Enter a frequency reference value of "500" in parameter 29 RFREQREF.
6. Starting and Stopping the Drive can be accomplished by one of the following methods:
   - Using 'Start' and 'Stop' buttons of the control panel or DMS function keys.
7. Start the Drive and observe the motor shaft for correct rotation.

8. If the Drive modulates, but doesn't turn the motor;
   - Verify that there are no mechanical problems with the motor or improper wiring connections
   - Increase the value of parameters 2003EE total drive current limit or 79EE IREMAX do not exceed 1000 or previously calculated limit.
9. If the Drive modulates, but still doesn't turn the motor, IR Compensation may be needed to increase motor voltage:
   - Increase the value of parameter 70EE (IRCOMPLVL) from 0, to 10, to 20, etc. to see if the motor will turn. An uncoupled motor should not require more than slight IR compensation (usually less than "50").

Checking Drive Feedback Values.

1. Once the motor is turning, check the following parameters:
   - 231 FRREF and 29 FREQREF should be equal.
   - 223 IRE has positive values.
   - 222 IQ has negative values.
   - Direction of motor rotation is correct.

CAUTION: If bypass circuitry has been provided, motor rotation should be checked in the bypass mode first. If adjustment is required interchange the leads at the input to the bypass main disconnect. DO NOT adjust the output or motor leads.

Motor Rotation/Feedback Correction Procedures.

1. If rotation direction is not correct, stop the Drive, remove power and perform the appropriate corrective procedure.
   - If the direction of rotation is incorrect and the value of parameter T231 is positive, stop the Drive, remove power and change two motor phase leads.
2. If parameters 223 IRE and 222 IQ have incorrect polarities:
   - Check that the current measurement leads are correctly installed.
   - Check the current transformers (Hall-effects) for damage and/ or proper installation including direction of motor leads.
   - Repeat the current measurement calibratio***n in Section 5-7***, Paragraph entitled "Calibration of the DC Bus Voltage Measurement".
3. Stop the Drive and motor.

Running Coupled.

1. Check that:
   - Motor is aligned.
   - Gearbox is lubricated.
   - Machine is lubricated.
   - Machine is ready to run.
   - Area in vicinity of section is roped off and personnel are clear.
2. Locate hard-wired COAST-STOP buttons at appropriate place, (at motor, by tending side of machine, by CP1 or DMS computer).
3. Arrange for maintenance representatives, with radio communications, to watch equipment and to keep in contact with the person(s) about to tune the equipment.
4. Set the speed reference, Parameter 29EE to a small value, 1000 or below.

IMPORTANT: *According to the machine manufacturers recommendations, raise the machine speed slowly until 1/2 of rated speed has been reached. Verify that no mechanical problems are present as the motor and load are accelerated. New machinery must sometimes be "Slow Crawled" for a specific break-in period before this step can be attempted.*

IR Compensation

Starting the Drive.

IRCOMPLIMIT 407EE is the frequency below which IR compensation current is limited by peak current measurement instead of IRE.

IRCOMPOINT 69EE can be lowered from 3000 if it appears that the motor is overexcited at half frequency.

IR compensation can be turned off, be adjusted manually or be set automatically by the Drive. Normally, automatic is a good way to start the Drive for the first time under load and for some applications, it may be advantageous to leave the Drive in the "Learn Mode" for all starts.

IMPORTANT: *All modes of IR Comp are not compatible with the Flying Start Option. If both features are required, consult ABB Drives Standard Drives Division.*

Manual setup of IR compensation.

1. Set IRCOMPSEL 85EE to 1 (no automatic search).
2. Set FREQREF 29 to a low level i.e. 500.
3. Set IRCOMPCURRENT 70EE to 0 or level required to turn uncoupled motor.
4. Start the motor.
5. Raise IRCOMPCURRENT 70EE until the motor starts turning while monitoring IREFILT 201EE.

Automatic Search of Maximum Compensation.

1. Set IRCOMPCURRENT 70EE to 200 (20% of rated inverter).
2. Set IRCOMPSEL 85EE to 3 and LEARNMODE 405EE to 1.
3. Start the Drive. The automatic search circuit increases the additional voltage if the drive reaches the peak current limit. The increase of voltage decreases the frequency reference value by means of the peak current controller until the drive starts to operate. If the drive is not able to start, the increase of voltage is terminated at the slip frequency.
4. To shorten the delay to start for subsequent start-ups, set LEARNMODE 405EE to 0 while the motor is running. Then use the value of additional voltage the Drive stored in AUTOTORQMAX 409EE by saving 409EE to EEPROM.

Constant IR Compensation.

If one Drive is feeding many motors that can be switched ON and OFF, the Drive can be set up to give additional voltage to the motors over the whole frequency range:

1. Set IRCOMPSEL 85EE to 1.
2. Set IRCOMPVOLTAGE 420EE to value required.
   (Scaling: 16125 = 100% voltage addition)

Once the motor is able to start properly, it should be accelerated throughout its complete speed range while monitoring currents and loading. Additional functions can then be initialized and adjusted to meet the application requirements.

Preset Frequency Reference

The standard Drive has a digital input assigned to "Preset Speed" start. This start command will start the specific Drive and run it at the frequency set in Parameter 161. The scaling of this value is in 0.01Hz (i.e. 20 Hz = 2000). If a second preset start exists, the frequency reference is in Parameter 162. For more preset speeds, consult your specific Drive Software Schematics.

Acceleration & Deceleration Rates

Parameters 64 and 66 set the independent acceleration and deceleration rates respectively. Units are 0.1 second per 100 Hz The value from the factory is 200 which is equal to 20 seconds per 100 Hz If, for example, an acceleration time of 10 seconds is desired to go from zero to 60 Hz, this would require conversion to a 100 Hz base, by multiplying 10 seconds by 100 Hz/60 Hz This results in a desired 16.7 sec/100 Hz The number entered into parameter 64 would be 167.

S-Curve Acceleration

The S-Curve acceleration feature provides a softer start at the beginning of the acceleration ramp and at the end of the ramp. This feature is normally turned on from the factory as standard. If rapid acceleration (less than 3 seconds) is required, this feature can be eliminated by setting parameter 91 to zero.

Minimum and Maximum Frequency Limits

The Drive has the capability of operating a motor from 0 to 200 Hz in either forward or reverse direction. The reverse frequency values in the Drive appear as negative numbers (i.e. - 6000 = 60 Hz in reverse). When adjusting the minimum or maximum frequency limit values, it may be necessary to adjust as many as four parameter values. Scaling is in 0.01 Hz units (i.e. 60 Hz = 6000).

CAUTION: Programming a maximum frequency limit above 60 Hz permits the motor to run above nameplate base speed. Hazard of personal injury or equipment damage exists if motor and driven machine are not rated for the programmed speed. Before entering a value, check motor/machine limitations.

To establish the Maximum Frequency Limits, Parameters 62EE and 1683EE need to be set to the same values.

To establish the Minimum Frequency Limits, Parameters 63EE and 1682EE need to be set to the same value.

Also the Analog Input scaling may need to be readjusted.

DC Braking

The operation of the program during DC braking is as follows:

1. After a STOP command, DC braking is activated if P96=1.
2. The modulator triggering pulse are removed for a period of time set by P75 RESTARTDELAY.
3. The modulator starts at a frequency of 0.02 Hz.
4. The current to the motor is ramped up to the value set by P345 DCBRAKECURRENT. The actual value of current can be monitored by P224I-TOT.
5. The motor will be supplied with this current for a period of time set by P346 DCBRAKETIME. After this time has elapsed, current to the motor will be stopped. The braking time can be changed during braking.
6. Current to the motor will always be stopped by either a fault or by a COAST STOP command.

Variable Slope Frequency Ramp

The slope of the frequency reference integrator (accel and decel rates) can be modified by the amount of change in the reference. This is accomplished by:

1. Activate the variable slope function by setting P460 = 1.
2. Set the period of time which has to elapse after the drive is commanded to START before the variable slope function is activated, by setting P461.
3. Set the update integration time, by setting P462. The amount of change in the output of the integrator is affected by the integration time and the amount of change in the reference from the pervious update. This integration takes place at the 21ms execution level.
4. During the period of time between the START command and until P461 has elapsed, the normal integration parameters P64 and P66 are used.
5. This variable slop function is not active after a STOP command is given.

Analog Outputs

The analog output parameters can be used to take any of the Drive parameters, scale it to the proper value for the analog to digital converter and provide an analog voltage or current signal output signal. The parameter is scaled from 0 to 255 for ANAOUT0 and ANAOUT1 and 0 to 4095 for ANAOUT2 and ANAOUT3.

The following table contains the parameters that provide the adjustment.

Table 5-6 Analog Output Adjustment Parameters

	ANALOG OUT0	ANALOG OUT1	ANALOG OUT2	ANALOG OUT3
Type **Resolution**	**Non-isolated Standard 8 bit**	**Non-isolated Standard 8 bit**	**Non-isolated Option 12 bit**	**Non-isolated Option 12 bit**
Minimum	2220	2221	2222	2223
Multiplier	1336	1340	2046	2050
Divider	1337	1341	2047	2051
Mode	1338	1342	2048	2052

Mode

The mode selection determines the range of the output signal and input signals.

ANAOUT0 and **ANAOUT1**

Mode = 0 Scaling of positive values. Voltage output is 0 to 5V. Current output is 0 to 1 mA.

Mode = 1 Scaling of signed values. Voltage output is 0 to 5V. Current output is 0 to 1 mA.

Mode = 2 Scaling of absolute value. Voltage output is 0 to. Current output is 0 to 1 mA.

ANAOUT2 and **ANAOUT3**

Mode = 0 Scaling of positive values. Voltage output is - +10V. Current output is 0 to 20 mA.

Mode = 1 Scaling of signed values. Voltage output is -10 to +10V. Current output is 0 to 20 mA.

Mode = 2 Scaling of absolute value. Voltage output is 0 to 10V. Current output is not in use.

Mode = 3 Scaling of absolute value. Voltage output not in use. Current output is 4 to 20mA.

Mode = 4 Scaling of absolute value. Voltage output not in use. Current output is 0 to 20 mA.

Mode = 5 Scaling of signed numbers. Voltage output not in use. Current output is 4 to 20mA.

Minimum Values - Parameters 2220, 2221, 2222 & 2223

These parameters should be set to the minimum value of the input parameter. For example: If the input were Parameter 208 (actual frequency) which was limited between 25 & 60 Hz, the minimum value should be set tot 2500 (25.00 Hz).

Multiplier - Parameter 1336, 1340, 2046 & 2050

These parameters should be set to the maximum input bit value of the D/A Converter.

PARAMETER 1336 & 1340 = 255; 2046 & 2050 = 4095

Divider - Parameter 1337, 1341, 2047 & 2051

These parameters should be set to the difference between the maximum and minimum values of the input parameter.

Using the same example as before, where frequency was limited between 25 and 60 Hz, the difference would be 6000 - 2500 or 3500 (35.00 Hz).

Drive Programming Adjustments & Operations

To provide flexibility for possible changing application needs, the Drive is fully programmable. In addition to programming the digital inputs and outputs and the five operator displays, the Drive contains a complete family of function blocks. These blocks allow the Drive to be configured to meet many demanding custom applications including P.I. Loop Control. This section covers several simple reprogramming adjustments that are possible with the standard Drive program.

1. Three or Two wire control
2. Jog function
3. Stopping Mode
4. Reversing function
5. PLC Interface Module
6. Slip Compensation
7. Stall Protection
8. Electronic Motor Overload
9. Critical Speed Avoidance

Three Wire vs Two Wire Control

The standard Drive I/O is set up for both three wire Start/Stop control and two wire control. For Three Wire Control, follow the instructions in Section 2. For Two Wire Control, simply use a maintained "Run" contact in the stop and start circuit, (X3-9 to X3-10) (OPEN = STOP, CLOSED = START).

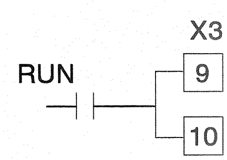

Figure 5-7 Two Wire Start/Stop

The standard software configuration is for three wire control. If the digital inputs are wired for two wire control (Eg. Jumper DINO to DIN1) and use a run contact to control the DIN1 input, the following operating characteristics will occur:

- Closing the "RUN" contact (DIN1) will start the drive (Drive must have been stopped for one second).
- Opening the "RUN" contact (DIN1) will stop the drive.
- The start push-button on the local control panel will not function. (Its command is being overridden by the status of DIN1-STOP).
- If the drive is stopped via the stop push-button on the local CP1 Control Panel, it can only be restarted by the start push-button on CP1 or opening the 'RUN" contact and then reclosing.

IMPORTANT: *To minimize nuisance trips caused by starting into a rotating motor, there is a one second delay between the time the Drive Frequency Output stops and a closed contact signal (to start the Drive) is accepted.*

Jog Function

In the standard software one digital input is used as a "Jog" input by adjusting Parameter 2040 as shown in Table 5-10. The Jog Speed Reference is Parameter 161.

Table 5-8 Jog Status Parameters

Parameter	Preset (Default)	JOG
2040	1582	1659

Stopping Modes

There are three possible stopping modes for the Drive:

Mode 1 Emergency Stop.

Mode 2 Coast Stop.

Mode 3 Ramp Stop.

The Standard Drive is set up for Mode 1 and 2. If desired, the Drive can be set to ramp stop instead of coast stop by making the adjustments shown in ***Table 5-11.*** The braking power is limited to the losses in the Drive and motor, about 2% of Drive rating. If additional braking capability is provided via common DC bus, braking resistors or regeneration to the supply line, Parameter 80 Regenerative Current Limit requires tuning. Set it to the negative of the value found in Parameter P79 (Eg. If P79 = 800, then set P80 = -800).

CAUTION: The user has the ultimate responsibility to determine which stopping method is best suited to the application and will meet applicable standards for operator safety.

Table 5-9 Ramp Stop Status Parameters

Parameter	Coast Stop Value (Default)	Ramp Stop Value
1389	1582	2042
1390	2042	1426
2041	1426	0
80	-300	Neg Par 79

Reversing Function

The standard control software program has a provision for electronic motor reversing. To enable or disable the reversing function, it is only necessary to change the value of Parameter 1615 as detailed in the following table.

Table 5-10 Reversing Functionn

Parameter	Non-Reversing (Default)	Reversing Enabled
1615	1580	1581

Setting the minimum frequency limit to "0" will additionally assure that the reverse function is inhibited.

PLC Interface Module Input

The PLC Interface Module can be used to monitor the Drive operation and:

1. Control the Drive by overriding the digital inputs.
2. Supply the frequency reference when in the Remote mode.

Any combination of these operating modes is possible utilizing the standard software. For more information contact ABB Industrial Systems Inc.

Slip Compensation

Slip compensation (Figure 5-6) is an option that is used to improve the speed regulation of the Drive without the use of tachometer feedback.

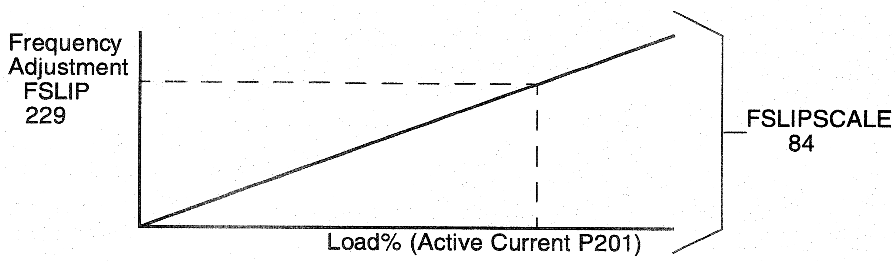

Figure 5-3 FSLIP vs. Load

The P208 output frequency is increased by an amount proportional to the (average active current IRE-FILT201). The maximum amount of slip compensation is set with FSLIPSCALE 84 and the output is FSLIP229 (100 = 1 Hz). FSLIPSCALE should be set equal to the full load slip frequency of the motor in 0.01 Hz increments (100 = 1Hz). Slip compensation is not active below 10 Hz Slip compensation is selected by SLIPCOMPSEL 89 (1=ON).

Stall Protection

An optional Stall Protection circuit can be provided which is selected when STALLPROTECTSEL 86 is set to any non-zero value. If the frequency remains below the frequency set in STALLFREQW82 (1000=10Hz) for a time period in excess of STALLTIME 83 (10 = 10 seconds)., a fault 20 will be displayed on the CP1 Panel and the Drive will shut down.

Electronic Motor Overload Protection

Electronic Motor Overload protection is an optional feature that monitors the active current as a function of frequency and time to reduce the risk of overheating the motor at low frequencies. The following parameter table shows the required settings to enable this feature.

Table 5-4 Motor Overload Parameters

Parameter	Description	Default	Scaling
1763	Current at Zero Speed allowed on Motor	400	400 = 40% Motor FLA
1767	Current at Full Speed allowed on Motor	800	800 = 80% Motor FLA
2215	Minimum Frequency for Full Current	3000	100 = 1 Hz
2003	Maximum Torque	1000	% of Motor (1000 = 100%)
2000	Motor FLA	200	200 = 20 Amps
1547	Motor PF	870	870 = 87%
2217	Check Time	4000	Time 4000 = 400 sec
2218	Over Time	150	% of Check Time 150 = 15%

Overload capability of a motor is dependent on current level, time and operating speed figure 5-5. Thermal overload only consider the current and time factors. The Electronic Motor Overload Protection (EMOP) option figure 5-6 changes the allowable load as a function of frequency and time.

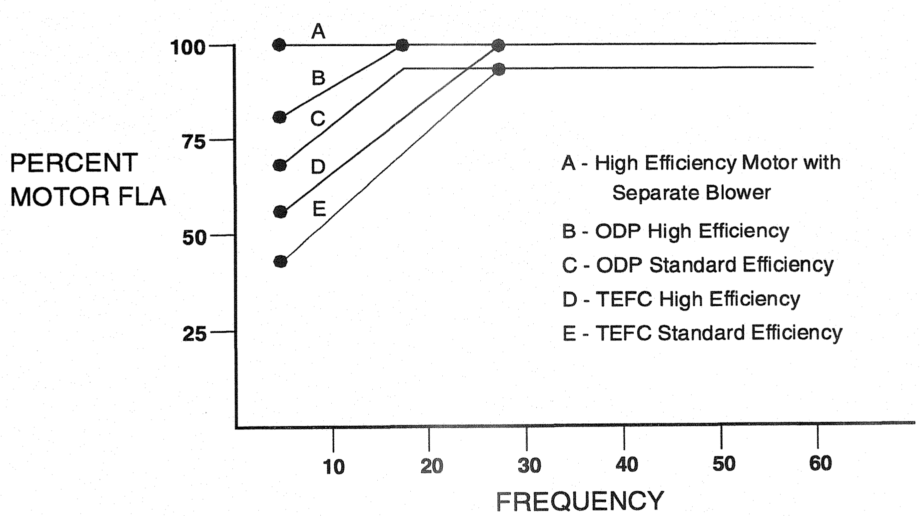

Figure 5-5 Typical Motor Load Vs. Frequency Curves

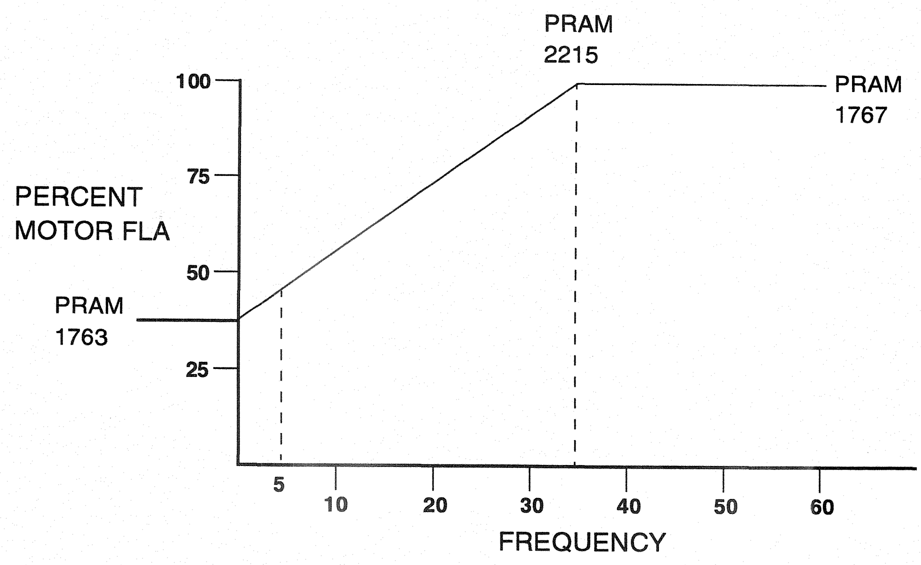

Figure 5-6 Electronic Motor Overload Protection Default Settings

The EMOP circuit will provide a FAULT 26 indication, trip and contact closure for customer use when the active motor current has exceeded the allowable duty cycle of the motor based on the operating frequency.

The input to the PROTECTOR block 2210 is the motor operating frequency FRACT208. If speed control option has been selected, then FACT 239 would be used. The output flag that indicates the motor has been overloaded longer than the allowable time 2213 is used to initiate a coast stop. The Electronic Motor Overload Protector uses the scaling factors from the standard software to determine inverter FLA and motor FLA which are used in the protector circuit. When the protector block is used, P2003 is set to maximum torque desired (as a% of motor Full Load Torque). This allows for momentary overloads.

The time of the overload (2218 OVERTIME) is set as a percentage of the monitoring time in 0.1% increments. The monitoring time (2217 CHECKTIME) is set in 0.1 second increments figure 5-7.

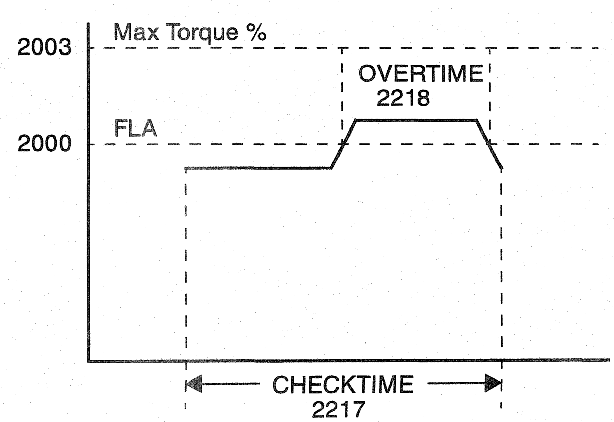

Figure 5-7 Electronic Motor Overload Time Settings

Critical Speed Avoidance

The 4.04A Firmware has an optional function block that allows the frequency of the Drive to bypass certain critical frequencies. This function block has two modes of operation, the first modifies the frequency reference when it falls within a critical frequency range. The second mode monitors the actual frequency to ensure that the motor accelerates through the critical frequency in a set amount of time. Critical frequency values are scaled so that 100 = 1Hz There may be as many as five critical speeds that can be specified in the block with high and low limits as follows:

CRITICL1	2197	Low Limit for Critical Speed 1
CRITICH1	2198	High Limit for Critical Speed 1
CRITICL2	2199	Low Limit for Critical Speed 2
CRITICH2	2200	High Limit for Critical Speed 2
CRITICL3	2201	Low Limit for Critical Speed 3
CRITICH3	2202	High Limit for Critical Speed 3
CRITICL4	2203	Low Limit for Critical Speed 4
CRITICH4	2204	High Limit for Critical Speed 4
CRITICL5	2205	Low Limit for Critical Speed 5
CRITICH5	2206	High Limit for Critical Speed 5
CONTROL	2195	Set to 0 the frequency reference is increased (decreased if in reverse) beyond the critical frequency range when the input setpoint is within the critical frequency range. When set to -1, it monitors the actual output frequency and when the motor remains in the critical range longer than allowed in ACCTIME 2196, the frequency reference is reduced below (above if in reverse) the critical frequency.
ACCTIME	2196	When control 2195 is -1, set to the allowable time (10=1 second) that the motor can safely remain in the critical frequency range.

IMPORTANT: *The critical speed limits use signed values of frequency and therefore when the drive is operating in reverse rotation, the high limit is the less negative number.*

For example: If a critical frequency is in the area between 10 Hz and 15 Hz in the reverse direction CRITICH1 would be set for -1000 (10Hz) and CRITICL1 would be set for -1500 (15 Hz).

RAM Battery Backup

In addition to being able to save the software program and all Drive adjustments to EEPROM, the Drive is equipped with a battery (Ni) backup for the following items in RAM:

Fault Words	Fault Messages	12 Programmable Values
Fault Buffers	Trend Buffers	

To engage the battery backup, Jumper S3 on the INU Control Card (A2-SAFT 187CON) should be set to position A-B.

If the battery backup is not properly engaged or the battery is dead, the control panel will intermittently display SA56. Once properly connected, the battery will recharge to a minimal level within two minutes. To remove the flashing SA56 message, the input power must be cycled.

CAUTION: Do NOT store spare boards or the Drive with power OFF while the jumper S3 is in position A-B. The jumper must be in position A-C for storage, or the battery will drain in a few days. Battery will recharge when power is applied.

Saving Changes

After completing the adjustments and selection, this information must be stored in the permanent memory. To do this, set Parameter 8 to +1 and wait for control panel CP1 to finish displaying "SA51" (Control Panel CP2 "Stored to Backup"). Parameter 8 must be reset to zero after 1 minute. This will insure no further changes or loss of memory, and/or unauthorized tempering with adjustments.

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Control Panel (CP1)

The CP1 Control Panel (SAFP 11 PAN) has several modes of operation and can be used to:

- Control Drive operation
- Alter Drive parameters
- Display operating values (i.e., Output Amps, Frequency)
- Display other "test" point values from within the Drive
- Display Fault Diagnostic Codes

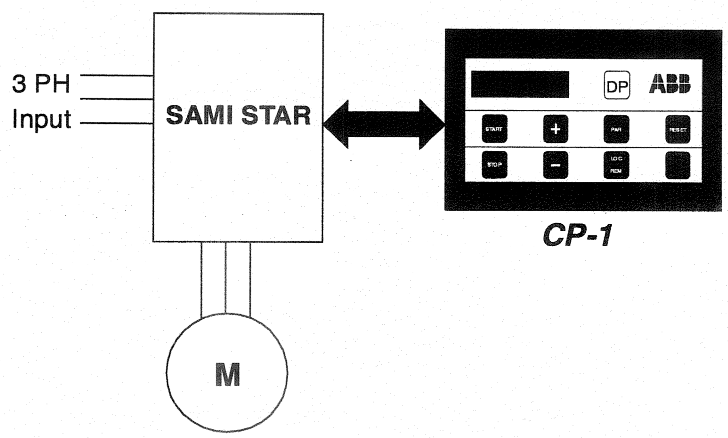


Figure 6-1 Control Panel CP1 in a Single-Motor Drive

The CP1 panel figure 6-1 is installed in the door of the cabinet and is connected to the terminal block card by a 20 pole flat cable. The panel contains 9 push-buttons and a digital display. The CP1 panel cannot be used for remote control. All set-up, operation and troubleshooting of the Drive can be carried out through the Control Panel.

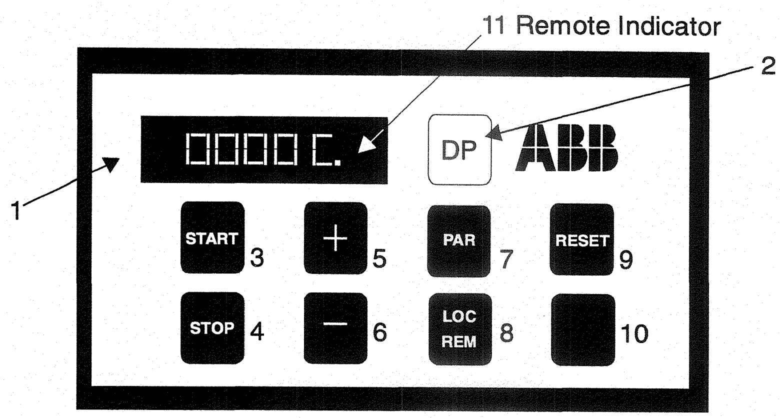


Figure 6-2 SAMI STAR CP-1 Control Panel

Table 6-1 lists the SAMI STAR Control Panel functions.

Table 6-1 Control Panel CP-1 Legend

No.	Function
1	Six Digit Display (Parameter Numbers, Fault Codes, or Operational Values)
2	Display Selection: Frequency, Current Voltage or Parameter
3	Drive Start
4	Drive Stop
5	Increase Frequency Reference, Increment Parameter Numbers
6	Decrease Frequency Reference, Decrement Parameter Numbers
7	Parameter Number Selection
8	Selection of Local or Remote Control
9	Fault Reset and Parameter Value Storage
10	Programmable Key
11	Remote Indicator Light

Operating the Drive

Controlling the Drive is simplified by the fact that the display buttons are self explanatory.

START & STOP are momentary push-buttons to start and stop the drive.

LOC/REM toggles between the local or remote frequency reference. Note the “Remote” indicator light in the display which indicates if the drive is following the remote reference. Initial power up of the drive will be in the local mode.

PROGRAMMABLE KEY This button is normally defined in software. To enable this button consult ABB Industrial Systems Inc.

RESET is used to reset any fault. It also serves another function when in the parameter mode (See Parameter Mode).

PARAM (See Parameter Mode).

DISPLAY (See Display Operation).

+ / - adjusts the local "C" reference when in the Operating (Normal) mode. Depressing the + button will increase the reference, depressing the - button will decrease the reference. Response may appear slow since the adjustment initially is made to the hundredth digit (0.01) which is not displayed. Keeping the button depressed will speed up the change as the adjustment digit will move to the tenths (0.10) and then to the unit digit (1.0). As you approach the desired value, release then repress the button to slow its rate of change.

Display Operation - In the normal operating mode, pushing the display button (Figure 6-3) will provide readings on:

- Drive Frequency References
- Output Frequency
- Motor Current
- Output Voltage

Pushing the display button will change from one display to the next.

The readings are identified by programmable code letters that appear after the readout on the display (Figure 6-3).

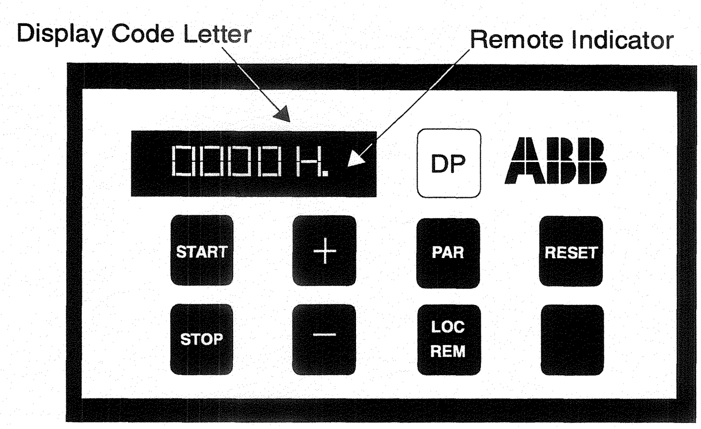


Figure 6-3 Control Panel Display

Five (5) of the codes have been preset at the factory to indicate the following readouts:

L Control Panel Local Frequency Reference

r REMOTE Frequency Reference

o Output Frequency (Hertz)

A Motor Load Current

U Output Voltage

If a fault occurs, a diagnostic code (Figure 6-4) corresponding to one of the following faults will be displayed:

- Overcurrent
- Undervoltage
- Overvoltage
- Overtemperature
- Semiconductor Fault or Failure
- Processor Fault or Failure
- Line Supply Unit (LSU) Failure
- External Interlock

For detailed explanations on Diagnostic codes and their probable causes, see Chapter 6, Troubleshooting Guide.

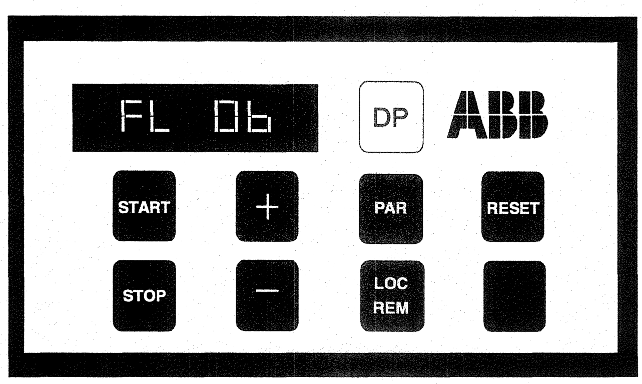


Figure 6-4 Control Panel Fault Code Display

Drive Maintenance System (DMS)

DMS is a software package used for configuring and diagnosing ABB Digital Drives, including the SAMI STAR, adjustable frequency drive control.

WARNING: This product is intended to be used by qualified personnel as setup and diagnostic tool only. Hazards of machine motion and personal injury exist.

Only qualified personnel should attempt setup or diagnostic routines to avoid possible machine damage or personal injury.

Choosing the Right Fault Tracing Instruction

The following paragraphs match the fault situations that constitute the starting points for fault tracing. In some cases, operating personnel will have to reset the fault and then attempt to restart the unit. The fault tracing procedure should start at the point corresponding to the original fault indication. Occasionally, the cause of a malfunction of the unit must be determined without any visible LED fault indications.

Diagnostics

The following sources of diagnostic information are available to the operator. The information is accessible via the local Control Panel and can be transmitted via the serial communication link as bit coded words.

1. Fault Queue.
2. Fault Words (Tables 6-1 through 6-3).
3. Drive Status Word.
4. Scalar Regulator Status Word.

Fault Queue

In the event of a fault, the fault that occurs first is stored in a buffer FLT-QUEUE 176. This location retains the data until the Drive is reset. After being reset, the fault code is moved to **Parameter (177)** and a **negative 1** is stored in **Parameter (176)**. If power is turned off, this data is backed up with a battery. If another fault occurs, all the data stored is moved to the next higher memory location and the new fault number is stored in **Parameter (176)**.

Assume that the drive has had three fault shutdowns, the first from overcurrent (05), the second from overtemperature (04) and the third from DC Undervoltage (07) as the initial causes of shutdown. After each fault, the drive was reset. The fault queue would contain the following:

Table 6-2 Fault Que Example

PARAMETER	FAULT #	EXPLANATION
176	-1	RESET
177	7	DC UNDERVOLTAGE
178	-1	RESET
179	4	OVERTEMPERATURE
180	-1	RESET
181	5	OVERCURRENT

NOTE: If several faults occur simultaneously, the program cannot define the relative sequence of the codes, thus, all codes are stored to the fault buffer.

Drive Status

The status of the drive is summarized in the Bit Word found at Parameter 214. The meaning of that word is decoded as shown in table 6-3.

Table 6-3 Parameter 214 Bit Decoding

MEANING	BIT #	DEC
NOT RUNNING	0	1
READY	1	2
FAULT	2	4
LOCAL/REMOTE	3	8

EXAMPLE:

Parameter Address

Parameter Data

214	**0100**

Parameter 214 contains the data 0100, 0100 = 4, the second bit is enabled, thus Drive Fault (from table 6-2).

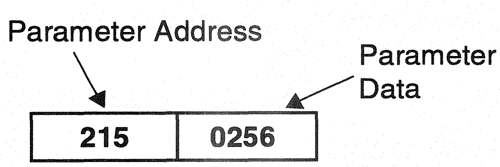
Regulator Status

The status of the Scalar Drives Internal Regulators are indicated by the bits in Parameter 215. The bit definitions are listed in table 6-4.

Table 6-4 Parameter 215 Bit Decoding

MEANING	BIT #	DEC
IDLING	0	1
RIDE THROUGH	1	2
FLYING START	2	4
FREQUENCY INTEGRATOR	3	8
IREHIGH CONTROLLER	4	16
IRELOW CONTROLLER	5	32
UCHIGH CONTROLLER (119%)	6	64
UCHIGH CONTROLLER (116%)	7	128
IR COMPENSATION	8	256
INDUCING FLUX	12	4096
TORQUE REGULATION	13	8192
IR COMP AT CURRENT LIMIT	14	16384
DC BRAKING ACTIVE	15	-32768

EXAMPLE:



Parameter 215 contains the data 0256, 0256=0000000100000000, the eighth bit is enabled, thus Drive IR Compensation enabled (from table 6-4).

Diagnostic Messages

The following Faultword listing is a composite of all diagnostics messages transmitted to the Control Panel. Messages with a FL prefix turn the inverter off (exceptions FL25 & FL26). Status (SA) messages are warnings and do not shut down the unit but can prevent its start-up.

Faultword

The FAULTWORD parameters contain the fault codes and status messages for the Scalar program. All 32 codes are packed into the three Faultwords as shown in Tables 6-5 through 6-7. The Faultwords can be sent via serial communications to the control devices (PLC.DMS, etc.) A "1" in the bit indicates that the fault has occurred. If multiple faults are present, the number displayed would be the total of the decimal values of each fault.

Table 6-5 Faultword 0 Parameter 210 (Hardware Faults)

CP1 Fault #	CP2 Message Text	Description	Bit #	DEC
FL01	CHOP UNDERVOLT	Chopper Undervoltage	0	1
FL02	CHOP OVERVOLT	Chopper Overvoltage	1	2
FL03	AUX UNDERVOLT	Aux Undervoltage	2	4
FL04	OVERTEMPERATURE	Overtemperature	3	8
FL05	OVERCURRENT	Overcurrent	4	16
FL06	DC OVERVOLT	DC Overvoltage	5	32
FL07	DC UNDERVOLT	DC Undervoltage	6	64
FL08			7	128
FL09	U1 FAULT	Semiconductor U Phase Positive	8	256
FL10	U2 FAULT	Semiconductor U Phase Negative	9	512
FL11	V1 FAULT	Semiconductor V Phase Positive	10	1024
FL12	V2 FAULT	Semiconductor V Phase Negative	11	2048
FL13	W1 FAULT	Semiconductor W Phase Positive	12	4096
FL14	W2 FAULT	Semiconductor W Phase Negative	13	8192

EXAMPLE:

Parameter Address

Parameter Data

210	**0040**

Parameter 210 contains the data 0040, 0040=0000000000101000 (8+32), the third and fifth bits are enabled, thus Drive Overtemperature and DC Overvoltage Faults have occurred (from table 6-5).

Table 6-6 Faultword 1 Parameter 211 (Software Faults)

CP1 Fault #	CP2 Message Text	Description	Bit #	DEC
FL15	SHORT CIRC/EFLT	Short Circuit/Ground Fault	4	16
FL16	COMMUNIC FAULT	Communication Fault Channel 1	12	4096
FL17	COMMUNIC FAULT	Communication Fault Channel 2	13	8192
FL18	TACHO LOSS	Tachometer Fault	15	-32768
FL19	I MEAS FAULT	Current Measurement Fault	0	1
FL20	MOTOR STALLED	Motor Stalled	14	16384
FL21	MATCH CARD FAULT	Matching Board Fault	1	2
FL22	PROCESSOR FAULT	Processor Fault	2	4
FL25	DIS25 FAULT	Programmable	8	258
FL26	DIS26 FAULT	Programmable (Typical Motor Overload)	9	512

Table 6-7 Faultword 2 Parameter 212 (Status Data)

CP1 Fault #	CP2 Message Text	Description	Bit #	DEC
*SA50	NO BACKUP/NEW EP	Empty EEPROM	0	1
SA51	STORED TO BACKUP	Saving to EEPROM	1	2
SA52	NO WR TO EEPROM	Saving to EEPROM Inhibited	2	4
SA53	PARAM TOO HIGH	Parameter Value Out of Limit	3	8
SA54	PARAM TOO LOW	Parameter Value Out of Limit	3	8
SA55	ILLEGAL PARAM	Illegal Parameter Change Not Permitted	4	16
SA56	NO BATT BACKUP	No Battery Backup	13	8192
*SA57	LOW AC/DC VOLT	Low AC/DC Voltage	5	32
*SA58	START INHIBIT	Startup Inhibited	7	128
SA59	SYSTEM RESTART	System Restart	6	64

*These inhibit start of Drive.

Diagnostic Facilities

To provide the diagnostic information, the program contains a comprehensive diagnostics facility which can be used for Drive adjustments and especially for troubleshooting. The diagnostics includes the following functions which will be described in detail.

- Memory battery backup.
- Status and fault messages.
- Short-circuit and earth-fault testing during start-up (GTO).
- Serial data communications monitoring.
- Eight trend buffers.

In addition, the program has a control program for the 4-channel D/A converter.

Memory Battery Backup

Battery backup is connected to the SAFT 187CON Control Card by means of selector S3 (a-b position). In the event of a supply voltage failure, the program stores the following data to battery protected memory locations.

fault words FAULTWORD 0...2	210M...212M
fault buffer FLTQUEUE	176M...181M
trend buffers TRENDBUF1...8	500M...1299M
fault display (FL)	

In addition, when using function blocks, 12 extra parameters can be stored to the memory by means of the application program RAMSTORE functional block.

Status and Fault Messages

When a fault occurs, CP1 reports a fault code and CP2 displays a fault message and the fault words can be transmitted to another master controller. The CP1 codes are divided into “FL” Drive tripping type codes and “SA” codes which do not stop a Drive but can prevent its start-up.

The “FL” messages are continuously displayed and should be reset by means of the RESET push-button (with the exception of the functional block, programmable faults FL25 and FL26). If a fault is displayed when a power failure occurs (battery backup connected), the fault message reappears when the power supply is reconnected. This does not, however, inhibit a start-up of the inverter if the actual fault has been eliminated. The fault message is removed by pressing the RESET push-button.

The “SA” type messages are displayed for a short period of time or a message is blinking unit the fault is eliminated. Under normal conditions, status messages need not be reset, with the exception of the SA56 messages associated with the battery backup and the SA52 associated with the use of EEPROM. For a list of the SA messages see table 6-7 and the Troubleshooting guide at the end of this chapter.

Faults FL1 to FL14 are transmitted directly from the cards as hardware interruptions. See card descriptions in Chapter 3 and the Troubleshooting Guide.

FL01 Capacitor circuit voltage too low. Probable causes are loose connections or possible capacitor malfunctioning.

FL02 Capacitor circuit voltage too high. Probable causes are loose connections or possible Chopper Control Card malfunctioning.

FL03 The voltage supply to the circuit boards is insufficient. The voltage supply to the Drive is too low, DC Bus voltage (UC) is low or DC Bus in not charged. Other causes could be hardware related, such as auxiliary 215 VAC supply to INU is low or missing, or the Auxiliary Power Card is malfunctioning.

FL04 The inverter heatsink temperature is too high. Check for possible causes of high temperature. Obstructed cooling air flow or the room air temperature is too high.

FL05 The Instantaneous Peak Current has exceeded 230% of Drive rating.

FL06 The DC Bus (Uc) Capacitor Voltage has exceeded 130% of rated.

FL07 DC Bus Voltage (Uc) Capacitor Voltage too low.

FL09, V11-U1 FAULT
FL10, V14-U2 FAULT
FL11, V12-V1 FAULT
FL12, V15-V2 FAULT
FL13, V13-W1 FAULT
FL14, V16-W2 FAULT
(GTO 40-870 KVA Only)

Power semiconductor device or pulse amplifier malfunction. For example: V12-V1 FAULT refers to the power semiconductor of positive branch of "V" phase or its pulse amplifier.

FL09, V1 FAULT
FL10, V4 FAULT
FL11, V2 FAULT
FL12, V5 FAULT
FL13, V3 FAULT
FL14, V6 FAULT
(GTR 30-115 KVA Only)

Power semiconductor device or pulse amplifier malfunction. For example: V5 FAULT refers to the power semiconductor of positive branch of "V" phase or its pulse amplifier.

Faults FL15 to FL26 are faults monitored through the program.

FL15 Short-circuit and ground-fault test.

A short-circuit or an ground fault occurring in the output terminals could lead to serious damage of the components, particularly in GTO inverters. For this reason, a test for measuring a possible short-circuit or ground-fault current in the inverter output is executed prior to start-up in connection with the GTO-inverter chopper charge program. If the peak current IPEAK 244 is higher than the limit set by parameter E_S_LIMIT 275EE, the program displays the fault message (FL15). The indication is not precise and occurs only during the start-up procedure so that is cannot be used for actual earth-fault protection. In GTR inverters, only an earth-fault test is executed.

FL17 Serial data communications supervision.

The SAFT 187CON Control Card has two serial data communication channels which can be supervised independently. Monitoring is based on the principle of time measuring between received messages. If the interval between messages is too long, actions to be performed can be defined by means of the SELMACONT 171EE parameter. The duration of the permissible delay is determined by the COMM_TIMEOUT 172EE parameter (channel 1) and the COMMTIMEOUT2 157EE parameter (channel 2).

Action in the event of a break in the data communications link, SELMACONT;

171EE	= 0	no supervision.
	= 1	reported to Control Panel.
	= 2	reported and stopped by downward integration.
	= 3	reported and shut down immediately.

Permissible transmission delay for channel 1.COMM_TIMEOUT;

172EE	= 0	no supervision of channel 1.
	= 1	24 ms.
	= 2	48 ms.
	= 3	72 ms, etc.

Permissible transmission delay for channel 2, COMM_TIMEOUT2;

157EE	= 0	no supervision of channel 2.
	= 1	24 ms.
	= 2	48 ms.
	= 3	72 ms, etc.

FL18 Tachometer fault. If the difference between two successive speed measurements is greater than TACHORIPPLE 78EE, a tachometer fault is suspected and a "TACHO LOSS" message is displayed. After start, tach pulses must be received within the delay set by TACHODELAY 174EE. Both monitoring functions can be bypassed by setting the appropriate parameters to zero.

FL19 If the program cannot eliminate the current offset automatically, a current measurement fault message is displayed. A fault message is displayed also if IPEAK is higher than 2.36V in the A/D-converter input.

FL20 Drive has been at current limit and below stall frequency for too long. Stall protection is set-up in Chapter 5 for Scalar Drives.

FL21 Wrong bit pattern on the matching card.

FL22 Fault message is displayed if the card is unable to function. For example, if the software or the hardware is unable to keep the modulator in operation or the processor is unable to read the EPROMS correctly.

Trend Buffers

The inverter software contains 8 sampling buffers with 100 samples capacity. The buffers can be used to acquire data showing behavior of the measuring points.

TRENDBUFSEL 93 selects the trend buffer option for Scalar Drives.

A sampling internal can be selected in a range which corresponds to time interval 3 ms to 196 s/sample for Scalar, 4 ms to 262 s/sample for Vector.

A triggering condition can be set for the first trend buffer which stores status data to the memory for a closer analysis.

Trends can be examined in analog form by monitoring a desired trend buffer content using D/A converter or watching trend numeric values on the Control Panel.

Selection of the memory addresses to be monitored.

Set the measuring point number to the trend control address that you are going to use.

Trend control addresses are:

191EE	Trend buffer 1 connecting point.
192EE	Trend buffer 2 connecting point.
193EE	Trend buffer 3 connecting point.
194EE	Trend buffer 4 connecting point.
195EE	Trend buffer 5 connecting point.
241EE	Trend buffer 6 connecting point.
242EE	Trend buffer 7 connecting point.
243EE	Trend buffer 8 connecting point.

Selection of Sampling Interval

A sampling interval can be selected by means of the parameter TRENDIVAL 196EE:

196EE	= 0	sampling is synchronized to the modulator.
	= 1	3 ms interval sampling (4 ms).
	= 2	6 ms interval sampling (8 ms).
	= 3	9 ms interval sampling, etc. (12 ms).

Selection of Triggering Condition

A trend triggering (Figure 6-5) occurs every time the inverter detects a fault, irrespective of the triggering condition. The trend triggering point then records 80 samples before the fault instant and 20 samples after it.

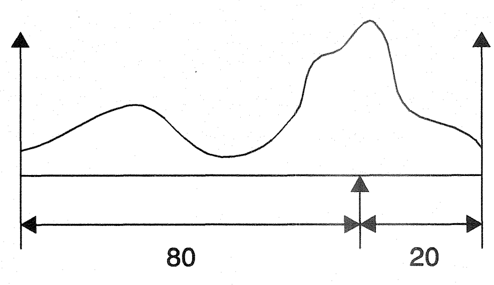


Figure 6-5 Trend Triggering Caused by a Fault

A triggering condition (Figure 6-6) is set for the first trend buffer by means of the parameter TRENDTRIG 197EE.;

197EE	= - 1	triggering caused by a fault only.
	= < > - 1	triggering occurs when the deviating of two successive samplings exceeds the value set at this location.

A triggering (Figure 6-7) can also be initiated manually by setting TRENDSAVE 199 < > 0. The trend values of the triggering instant are then saved. 199 is automatically set to zero.

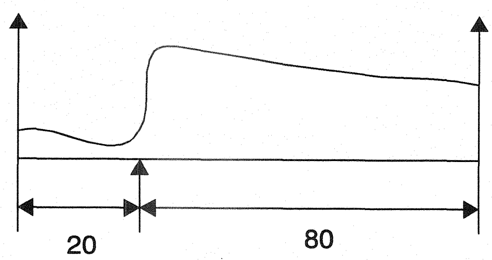


Figure 6-6 A Conditional or Manual Triggering.

Monitoring of the Trend Triggering

The content of the TRIGCOUNT 200 measuring point is incremented every time a trend triggering occurs. This can be used to control that the triggering condition is satisfied.

Trend Content D/A Conversion

The 4-channel D/A converter SAFT 154 DAC or the I/O cards own converters can be used for the trend content D/A conversion. Each trend buffer has an address which is used by the D/A converter to convert trend discrete data to the analog form (Figure 608). The converter should be scaled to the monitored signal magnitude.

The addresses are:

320	Trend buffer 1
321	Trend buffer 2
322	Trend buffer 3
323	Trend buffer 4
324	Trend buffer 5
325	Trend buffer 6
325	Trend buffer 7
327	Trend buffer 8

The sample conversion interval is 210 ms/sample. The sampled data contain a synchronizing pulse which identifies a trends start instant, as shown in figure 6-7.

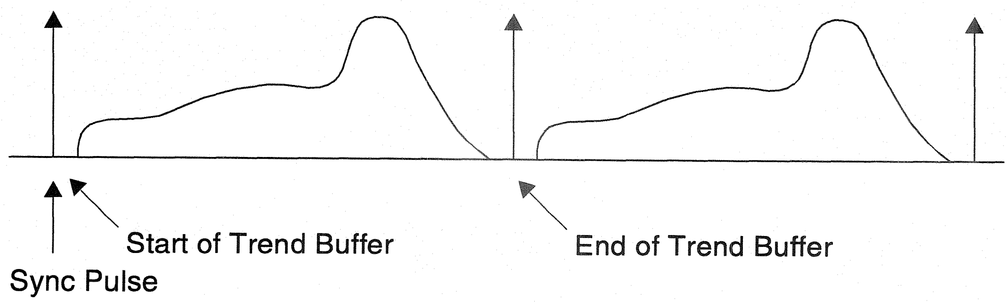


Figure 6-7 An Analog Representation of a Trend Buffer Discrete Content

Monitoring the Numeric Content of the Trends on the Control Panel - The numeric values of the trends can be monitored at the measuring points 500M to 1299M as follows:

500M... 599M	Trend buffer 1
600M... 699M	Trend buffer 2
700M... 799M	Trend buffer 3
800M... 899M	Trend buffer 4
900M... 999M	Trend buffer 5
1000M...1099M	Trend buffer 6
1100M...1199M	Trend buffer 7
1200M...1299M	Trend buffer 8

The measuring points 320 to 327 can also be used on CP1. The content of these memory locations provide a general view of the trend development.

The diagnostic LED indicators provided with the SAMI STAR Drive are detailed in Table 6-8.

Table 6-8 LED Indicators

Card Location	Name	LED Identifier	Indication	Drive Size
A2	Control Card	H1	**ON** = Ready	All
			OFF = Not Ready or Running (GTO)	
			FLASH = Processor Fault	
A3	Power Supply	V58	ON = Power Supply OK	30-115 kVA
			OFF = Power Supply Low	
A4	Pulse Amplifier	H101	ON = Positive U Phase OK	30-115 kVA
		H201	ON = Positive V Phase OK	30-115 kVA
		H301	**ON** = Positive W Phase OK	30-115 kVA
		H401	ON = Negative U Phase OK	30-115 kVA
		H501	ON = Negative V Phase OK	30-115 kVA
		H601	ON = Negative W Phase OK	30-115 kVA
			OFF = Device Fault	
A4-A6	Pulse Amplifier	H1 (Positive)	ON = Normal Operation	140 kVA & Above
		H2 (Negative)	OFF = GTO Fault	140 kVA & Above
A7	Chopper Card	V42	ON = Aux. Voltage OK	140 kVA & Above
			OFF = Aux. Voltage Low	140 kVA & Above
A9	Power Supply	V40	ON = Power Supply OK	140 kVA & Above
			OFF = Power Supply Low	
CBU-A1	Capacitor Supv. Card	V27	ON = Normal Voltage	140 kVA & Above
		V28	OFF = Low Voltage or Bypassed	
		V29		
		V30		

Troubleshooting Guide

Diagnostic Display	Symptom	Probable Cause	Recommended
None	Drive Dead. Main Contactor will not close.	A. Main Disconnect not closed. B. Maintained Emergency Stop depressed. C. Low or no voltage at supply to Drive. D. Blown Fuses. E. Control Voltages Missing. F. Fault Interlock Open. G. 210 kVA units and above only. LCU Cooling Fan Circuit Breaker is Off or Tipped.	A. Close Disconnect. B. Reset Emergency Stop. C. Provide correct voltage. Voltage of all three-phases must be +\- 10% of nameplate rating &within 5% of the other phases. D. Check or replace LSU fuses F1 through F8. E. If applicable, check for 115V AC between terminals TB1-24 and TB1-25. Check for 215V AC between TB1-9 and TB1-12. F. If applicable, check for Interlock or jumper continuity at: Terminals TB1-20 & 21 Terminals TB1-21 & 22 Terminals TB1-22 & 23 Terminals TB1-15 & 16 G. Reset Breaker F51 in LCU. Check fan for free rotation. Check heatsink thermostats S51 and S52 for open circuit.
	CP1 Panel Blank. Drive seems to be dead, but cooling fans run.	A. Maintained Emergency Stop depressed. B. Blown fuses. C. Control voltages missing.	A. Reset Emergency Stop. B. Check or replace LSU fuses F1 through F8. C. If applicable, check for 115V AC between LSU Terminals TB1-24 and TB1-25. Check for 215V AC between LSU Terminals for 215V AC between INU Terminals X1.1, 101 and 102.
None	CP1 Panel Blank. Drive seems to be dead, cooling fans do not run.	Cooling fan circuit breakers are off or tripped.	Reset breakers. F2 in INU (30 to 115kVA) F11 in INU (140 to 870 kVA) F51 in LCU (210 to 870 kVA) If breaker trips again, check fans for free rotation. If INU fan breaker continues to trip, temporarily remove jumper on INU X1 (103-104). (Run at no load) if breaker trips, replace A3 Power Supply on units 115kVA and smaller. On larger units, replace A9 Auxiliary Power Supply. If breaker doesn't trip, replace the cooling fan.
Any Display	Drive stopped but appears to be running.	Electronic noise.	Verify that grounding practices have been followed. **(Chapter 2).**
Display Character	Displays are strange. Drive doesn't operate as programmed. All memory appears to be lost.	Electronic noise has erased EEPROM.	Verify grounding. (Chapter 2). Replace D16 Chip with another chip containing new software or reload your program.

Diagnostic Display	Symptom	Probable Cause	Recommended
None	Main fuses blown.	A. Insufficient precharge time. B. Precharge resistor open. C. Malfunctioning Main Contactor Unit. (K4) D. Malfunctioning diode rectifier. E. Cap. bank or inverter shorted "+" to "-". F. Excessive voltage at input to Drive terminals.	A. Verify precharge timer TR1 is set to value shown on schematic diagram, but not less than 0.5 seconds. B. Measure precharge resistor values (typically 10 ohms each) replace if necessary. Check that K3 energizes during precharge time and de-energizes after precharge time. C. Open Main Disconnect and verify contactor operates freely. D. Replace G1, G2, or G3 (30 to 180kVA), G51, G52, or G53 (210 to 340kVA), or V41, V56, on 460 to 870 kVA units. Check/replace bad diodes. E. Inspect/measure capacitors and bus circuits. F. Measure input voltage. Voltage must be within +/-10% of nameplate rating (460V AC or 575V AC) and within 5% of other phases.
None	Main Fuse Blown Periodically While Running	A. Diode rectifier is weak and malfunctioning. B. Capacitor bank or inverter intermittently shorts "+" to "-". C. Excessive voltage at input to Drive terminals. D. Intermittent single phasing of incoming 3-phase power. E. Phase voltage unbalance greater than 6.5%.	A. Replace G1, G2, or G3 (30 to 115kVA units), G51, G52, or G53 (210 to 340 kVA). Check/replace bad diodes. V51-V56 (460 to 870kVA). B. Inspect/measure capacitors and bus circuits. Check for loose wires or material in bus circuits. C. Check input voltage. Voltage must be within +/-10% of nameplate rating (460V AC or 575V AC). D. Check supply network cables, terminations and switches. E. Correct cause of voltage imbalance in supply lines.
None	DC Bus fuses blow while running or starting inverter. (140kVA and above only.)	A. Capacitor bank or inverter intermittently shorted "+" to "-".	A. Inspect/measure capacitors and bus circuits. Check for loose wires or material in bus circuits. Check for worn or cracked insulation on main power conductors.
None	DC fuses blow when main contactor K4 is closed.	A. Short circuit in the inverter. B. Misfiring of GTO Thyristors. C. Inverter intermittently shorted "+" to "-" or to chassis.	A. Check for short circuit in semiconductor and replace if necessary. B. Check data of fault queue Parameters 176-181. C. Inspect/measure capacitors and bus circuits. Check for loose wires or materials in main circuits. Check for worn or cracked insulation on main power conductors.

Diagnostic Display	Symptom	Probable Cause	Recommended
FL01 (CP1) CHOP UNDERVOLT (CP2) (140kVA and larger)	C9 Capacitor circuit voltage too low.	A. Loose connections. B. INU A7 Chopper Control Card malfunctioning. C. Short circuited capacitors C9.1-C9.N D. V17 Chopper Thyristor malfunctioning. E. INU A4 Pulse Amplifier malfunction. F. Chopper charge time too short.	A. Verify solid connections at chopper bus bars. Re-seat connections on INU A7 Chopper Control Card. Verify connections at thyristor V17. B. Inspect/replace fuse F1 on A7 Chopper Control Card. Replace INU A7 Chopper Control Card. Verify that the INU Cooling Fan Breaker F11 and Temperature Sensor S1 are closed. C. Disconnect the chopper capacitors from the circuits at the Bus Bars. Inspect and measure capacitors for short circuits. D. Replace V17 and V28 thyristors. Check/replace INU A8 Snubber Card. E. Replace A4 Pulse Amplifier. F. Check that CHARGETIME 158EE is set to at least 6.
FL02 (CP1) CHOP OVERVOLT (CP2)	C9 Capacitor circuit voltage too high.	A. Loose connections. B. INU A7 Chopper Control Card malfunctioning.	A. Tighten connections at chopper bus bars. Re-seat connections on INU A7 Chopper Control Card. B. Replace INU A8 Chopper Control Card
FLO3 (CP1) AUX UNDERVOLT (CP2)	Voltage Supply to the Circuit Board is insufficient.	A. Voltage Supply to the Drive is too low. B. DC Bus voltage (UC) is low or DC Bus is not charged. C. Auxiliary 215V AC supply to INU is low or missing. D. Power Supply INU - A3 or Auxiliary Power Card INU A9 is malfunctioning.	A. Check incoming supply voltage. Voltage must be within +/-10% of nameplate rating and each phase within 5% of each other. B. Check condition of DC bus. C. Measure 215V AC supply to INU at terminals. Replace auxiliary power card if necessary. Verify INU cooling fan breaker F2 or F11 is closed. D. Check fuses on INU-A3 Power Card (INU-A9 on units 140 kVA and larger). Check status of LED on Power Supply Card INU A3. Replace card if necessary. Check status of LED on Auxiliary Power Supply Card INU A9. Replay card if necessary.
FLO4 (CP1) OVERTEMPERATURE	INU Heatsink temperature is too high.	A. Obstructed cooling air flow. B. Room air temperature too high. C. INU cooling fan is malfunctioning or is stalled. D. Heatsink thermal switch has malfunctioned or has open connection. E. Overtemperature circuitry has malfunctioned. F. Unbalanced phase voltage.	A. Remove any obstructions from louvers or heatsink. B. Cool air temperature to below 104°F (40°C). C. Check cooling fan circuit breaker. Check that the fan rotates and remove any obstructions. Replace fan if necessary. D. Check that the thermal switch located at the top of the INU is not open, replace if required. Check continuity to A-3 power supply or A-7 Chopper Control. E. Replace the INU-A3 power supply (115kVA and smaller drives). Replace the INU-A7 Chopper Control (140kVA and larger Drives). F. Correct cause of unbalanced phase voltages to within 5%.

Diagnostic Display	Symptom	Probable Cause	Recommended
FL05(CP1) OVERCURRENT	The Instantaneous Peak Current has exceeded 230% of Drive rating.	A. A sudden increase in motor load occurred. B. A mechanical bind has caused high currents. C. Problem exists in motor circuit. D. IR Compensation setting incorrect. E. Problem with accel/decel rates. F. Attempted to start before motor EMF decayed.	A. Check the process for unusual load or jam. B. Check for bearing, belt or gear failure. C. A motor winding has shorted or grounded. A motor winding or connection has an open circuit. Check motor circuit with appropriate meter. D. Check and reset IR Compensation. Check and reset current limit. E. Check and reset acce./decel rates. Try to adjust so that the Drive does not go into current limit, but follows the ramp instead. F. Increase Parameter 75 Restart Delay (1000 - 1 Sec.)
FL06(CP1) DC Overvolt	The DC Bus (Uc) Capacitor Voltage has exceeded 130% of rated.	A. Supply voltage to the drive is too high. B. The load has overhauled the motor. C. Regen torque limit too high. D. INU A3 Power Supply UC voltage measurement erroneous.	A. Maximum permissible supply voltage is 110% rated. Transformer taps must be changed to reduce AC voltage. B. The decel ramp is too rapid. Extend the decel ramp by increasing Parameter 66 value. C. Reduce value of the Regen Torque Limit Parameter 80 for Scalar Drives and Parameter 58, 59, 60, 61 for Vector drives. Controlled braking may be required. D. Check that Parameter 207 is between 900 and 1100. If the value is beyond these limits, replace INU-A3. Measure the actual DC Bus voltage with a meter. It should be 621V DC (460V). Verify values with Parameter 207. If the DC Bus voltage is OK, see Chapter 5to adjust or, replace INU-A-13. *Note: At no load, DC voltage may be as high as 716 volts with 6/460V input +10%.
FL07(CP1) DC UNDERVOLT	DC Bus Voltage (Uc) Capacitor Voltage is less than 70% of rated.	A. DC Bus not charged. B. DC Bus fuse blown. C. INU-A3 Power Supply Uc voltage measurement erroneous.	A. Check if main contactor is closed. B. Replace fuse. C. Measure the actual DC Bus Voltage with a meter and verify the value with Parameter 207. If the DC Bus voltage is within +/-10% of 621V DC, see **Chapter 5** to adjust or replace INU-A3.
FL09, V11-U1 FAULT FL10, V14-U2 FAULT FL11, V12-V1 FAULT FL12, V15-V2 FAULT FL13, V13-W1 FAULT FL14, V16-W2 FAULT (GTO Only) (140 to 870kVA only)		A. Power semiconductor device or use amplifier malfunction. For example: V12-V1 FAULT refers to the power semiconductor of positive branch of "V" phase or its pulse amplifier.	A. Reset the fault. Drive will check for shorted cells, motor leads or ground faults. Fault 15 will be the acknowledgment if they are present. If the fault repeats check that pulse amplifier (cards A4, A5 and A6) LED's are lit. If not, check power supply connector X3 and condition of Fuses F1 and F2. Check fuses on Power Supply Card A3 and Aux Power Supply A9. If the fault cannot be located, it may actually be a FL 05 Fault. If it is not possible to reset the fault, check that the flat cables or control and pulse amplifier cards are firmly connected. Check the fuses F2 through F5 on the Power Supply Card. If a fuse is blown, check the power semiconductor device. If the fault isn't found, replace the pulse amplifier card or Control Card as required. Check Snubber diodes.

Diagnostic Display	Symptom	Probable Cause	Recommended
FL09, V1 FAULT FL10, V4 FAULT FL11, V2 FAULT FL12, V5 FAULT FL13, V3 FAULT FL14, V5 FAULT (GTR Only) (30 to 155kVA only)		A. Power semi-conductor device or pulse amplifier malfunction. For example: V5 FAULT refers to the power semi-conductor of positive branch of "V" phase or its pulse amplifier.	A. Reset the fault. Start-up the inverter. If the fault occurs again, there is a short circuit in the output connect or phase power semi-conductor device of the phase indicated by the fault code or pulse amplifier malfunction. In the case of no short circuit in the output connector, check the condition of the power semi-conductor device. If it is not possible to reset the fault, check that the flat cables of control and pulse amplifier cards are firmly connected. Check the fuses F2 thru F5 on the Power Supply Card. If a fuse is blown, check the power semi-conductor device. If the fault isn't found, replace the pulse amplifier card or Control Card as required.
FL15(CP1) SHORT CIRCUIT/GROUNDED FAULT (140kVA and Larger)	A low resistance Phase-to-Phase or Phase-to-Ground is detected.	A. Moisture in wire or motor insulation. B. Cracked or stripped wire insulation or termination tape. C. Motor circuit incorrectly wired or terminated. D. Motor winding shorted. E. ES Limit incorrect.	A. Dry out or replace. B. Replace wire or tape. C. Verify, inspect, correct and test with meggohmeter. D. Replace motor. E. Parameter 275 should be set to 100.
FL17(CP1) COMMUNICATION FAULT	Serial Data Communication has been interrupted or lost.	A. Drive improperly grounded. B. A1 Supply Card LED not illuminated. C. A1 Supply Card LED is illuminated. D. Fiber optic cables damaged or disconnected.	A. See Chapter 2 for proper grounding procedures. B. Check that the cables connected A9 auxiliary power supply and control card are firmly connected. C. Baud rate values are set incorrectly or A1 IOC card is malfunctioning. Replace IOC card if necessary. D. Check connections and replace cables if damaged or broken.
FL18(CP1) TACH LOSS	Tach pulses faulty or nonexistent, or motor has stalled.	A. Tach cables faulty or disconnected. B. Process overload has caused motor to stall.	A. Check condition of cables and that they are installed correctly. B. Check the motor and load for jamming and correct.
FL19(CP1) CURRENT MEASURING FAULT OR CURRENT FEEDBACK ERROR	A current signal is sensed when the inverter is stopped.	A. Current is being backfed from the motor. B. A Hall Effect transducer is giving an erroneous signal. C. The signal conversion to digital data is incorrect. D. Current offset limit incorrect.	A. A bypass or alternate supply voltage is present isolate the Drive output from the motor circuit. B. A ribbon cable connection to the Hall Effect Transducer is bad, or the transducer itself is malfunctioning and must be replaced. C. Check Parameters 219 and 220 for excessive value, they should be less than 1000. (Parameter 219 monitors U-Phase Current, and Parameter 220 monitors V-Phase Current.) Recheck calibration of the current measurement in Startup Chapter 5-7. Replace Control Card if necessary. D. Check Parameter 190. Value should be 50.

Diagnostic Display	Symptom	Probable Cause	Recommended
FL20(CP1) MOTOR STALLED (Scalar only)	Drive has been in current limit and below stall frequency too long.	A. Stall protection failure improperly adjusted. B. Load is too great for drive or motor. C. Stall time setting is too low. D. IR Comp level is too low.	A. Refer to Chapter 5 for adjustment procedure. B. Reduce load. C. Correct Stall Time setting at Parameter 83 ("O" = infinity). D. Readjust IR Comp. (Chapter 3)
FL21(CP1) MATCHING CARD FAULT		A. Matching Card INU A-2.2 Connection is loose or missing. B. Matching Card is malfunctioning.	A. Check that the matching card is firmly connected and that the matching card type corresponds to the inverter type. B. Replace Matching Card.
FL22(CP1) PROCESSOR FAULT	Processor information is erroneous.	EEPROMS D17 and D18 faulty or Control Card INU-A2 malfunctioning. S-5 and S-6 set for wrong size EPROM.	Turn power on and off and wait two minutes. Try operation again. Replace EPROMS D17 and D18 on Control Card if malfunction remains. Replace Control Card INU-A2. S-5 and S-6 = A-C.
FL25(CP1) INTERLOCK or CUSTOMER FAULT	An Interlock at a Digital Input is detected missing.	A. Custom Programmable Fault Signal.	A. Check Custom software drawing for application.
FL26(CP1) INTERLOCK or CUSTOMER FAULT	Same as FLT 25. (Normally used for motor overload. RTD Monitor. Motor Thermostat, etc.)	A. Motor running hot. B. Blocks run before 10C card ready.	A. Check for proper cooling air flow through motor. If motor is operating at below base speed, it may require a separate cooling fan. B. Reset faults.
SA50(CP1) NO BACKUP/NEW EP SA51(CP1) STORED TO BACKUP		There is no information in the EEPROM Memory. Writing to EEPROM Memory.	
SA52(CP1) NO WR TO EEPROM	Writing to EEPROM Memory is inhibited.	A. Position of S4 switch must be A-B to write. B. EEPROM D16 is faulty.	A. Check switch position. B. Replace D16 EEPROM with known good EEPROM.
SA53(CP1) PARAMETER OUT of LIMITS	Drive will set parameter value to min/max allowable.		Re-check value being entered for validity.
SA55(CP1) ILLEGAL PARAMETER - CHANGE NOT PERMITTED	Parameter remains at original value.		
SA56(CP1) NO BATT BACKUP	Insufficient voltage from NiCad battery.	A. Switch S-3 in A-C (battery OFF position). B. Battery has malfunctioned or discharged.	A. Change switch position. B. Allow 20 hours with power on for battery to recharge. Cycle power on and off to clear fault message. If message refuses to clear, replace battery or Control Card INU-A2.
SA57(CP1) LOW AC/DC Volt		Auxiliary Power is low.	Check Supply voltage.
SA58(CP1) START INHIBIT		Start is inhibited by the processor.	A stop signal overrides a start signal. Check logic sequencing external to drive. Check Start/ Stop buttons.
SA59(CP1) SYSTEM RESTART		The processor is initializing its operation. This normally occurs when power is first applied to a Control Card.	

Changing Printed Circuit Boards

The Drive incorporates printed circuit boards that require no adjustments as part of the normal troubleshooting and maintenance. This feature also helps simplify board replacement.

Circuit Board Replacement

The following steps should be adhered to when changing the printed circuit boards:

CAUTION: The CMOS circuits utilized on the control circuit boards can be destroyed by static charges generated by friction of materials made of synthetic fibers. Use of damaged circuit cards may also damage related components.

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1. Remove power by opening the disconnect switch and verify with a meter that all circuits are voltage free.
2. Carefully detach all ribbon cables, noting their location and orientation and whether the connectors were properly sealed.
3. Remove small metric mounting hardware with a screwdriver, taking care not to drop associated washers into other circuits of the Drive.
4. Lift out the circuit board in question, and check that the replacement board is correct before attempting installation. Install the new circuit board by replacing the mounting hardware and reinserting the connectors and switches in their correct location on the new board.

IMPORTANT: *A grounded wrist strap should be used when replacing circuit boards to guard against static discharge damage to the boards.*

Steps 1 through 4 apply to replacement of all printed circuit boards in Drive.

SAFT 187 CON Control Card Replacement

In addition to the previous steps, the Control Card of the Drive requires the additional transfer of the following components when changing cards:

1. Transfer EPROMS D17 & D18 to the corresponding locations on new Control Card using an I.C. removal/insertion tool for CMOS Circuits.
2. In order to retain the application software values and program, it will be necessary to transfer the EEPROM D16 to the new card.

CAUTION: EPROMS and EEPROM cannot be transferred between different versions of control cards.

NOTE: If the new EEPROM D16 is left in the replacement Control Card, it is important that you observe item "4" when first reapplying power.

3. Transfer the matching card and its spacers from the suspect board to the new control board by removing the four mounting screws from behind the card and reinstalling them in the proper location on the new card. Be sure to attach the X-2 connector firmly into its socket and latch the connector tabs.
4. When reapplying power to the Drive after installing a new Control Card, you must wait at least 2 minutes after the red LED on the Control Card lights before interrupting power or readjusting parameters. If you choose to use the new EEPROM (D16) which was supplied with the card, it can take as long as 3 or 4 minutes after the LED lights. If power is interrupted, process restarts.

Preventive Maintenance

WARNING: Servicing energized Industrial Control Equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of controlled equipment. Recommended practice is to disconnect and lockout control equipment from power sources, and release stored energy, if present.

Periodic Inspection

Industrial control equipment should be inspected periodically. Inspection intervals should be based on environmental and operating conditions and adjusted as indicated by experience. An initial inspection within 3 to 4 months after installation is suggested. See National Electrical Manufacturers Association (NEMA) Preventive Maintenance of Industrial Control and Systems Equipment, for general guidelines for setting-up a periodic maintenance program.

Contamination

If inspection reveals that dust, dirt, moisture or other contamination has reached the control equipment, the cause must be eliminated. This could indicate an incorrectly selected or ineffective enclosure, unsealed enclosure openings (conduit or other) or incorrect operating procedures. Replace any improperly selected enclosure with one that is suitable for the environmental conditions. Refer to NEMA Standard Enclosures for Electrical Equipment for enclosure type descriptions and test criteria. Replace any damaged or worn seals and repair or replace any other damaged or malfunctioning parts (e.g., hinges, fasteners, etc.). Dirty, wet or contaminated control devices must be replaced unless they can be cleaned effectively by vacuuming or wiping. Compressed air is not recommended for cleaning because it may displace dirt, dust or debris into other parts or equipment, or damage delicate parts.

Cooling Devices

Inspect blowers and fans used for forced air cooling. Replace any that have been bent, chipped, or missing blades, or if the shaft does not turn freely. Apply power momentarily to check operation. If unit does not operate, check and replace wiring, fuse, starting capacitor, blower or fan motor as appropriate. Clean or change air filters as recommended in the product manual. Also, clean fins of heat exchangers so convection cooling is not impaired.

Replacements

Use only replacement parts and devices as recommended by ABB Drives to maintain the integrity of the equipment. Make sure the parts are properly matched to the model, series and revision level of the equipment.

Final Check Out

After maintenance or repair of industrial controls, always test the control system for proper functioning under controlled conditions that avoid hazards in the event of a control malfunction.

Keep Good Maintenance Records

This rule will be most helpful in locating possible intermittent problems by pointing to a particular area of recurring trouble within the overall system. Further, good maintenance records will help reduce major costly shutdowns by demanding the use of proper test equipment and an appropriate inventory of spare parts.

Appendix A - Parameter Table

Parameter Table

A list of Firmware Parameters along with a key to help clarify the parameter abbreviations is provided in the following tables.

D =	Decimal address
H =	Hexadecimal address
TYP =	-Blank-, if the value is saved only in the RAM memory and is not protected against power breaks, EE, if the value is stored in the EPROM memory M, if the value has battery backup.
H. Lim. =	Largest number that can be stored at the given address. If the number is not provided, the high limit is +32767.
Low Lim. =	Smallest number that can be stored at the given address. If the number is not provided, the low limit is -32767.
Init =	Initial value which is stored to the EEPROM when it is empty. The value is equal to 0 if the initial value is not given.
Name =	Explanation. If not present, there is no meaning in the given program version.

Unless otherwise noted:

Frequency values are in .01 Hz.

Time values are in .1 seconds.

Voltage values are in .1% of rated.

Current values are in .1% of rated.

If both H. Limit and Low Limit are zero, the parameter cannot be changed except by the program.

Firmware Parameters

D	H	TYPE	MAX	MIN	INIT	NAME
1	001					DATABLOCK50 is for Serial Input (i.e., DRC, DMS PLC Interface or Computer). It sends to this location data, which is used as input for application blocks (e.g., start request or frequency reference).
2	002					START1 is start request to freq. ref. 29 or Sped. ref. 27.
3	003					STOP is a stop command. Will integrate frequency towards zero and the modulation will stop when frequency is lower than 77EE.
4	004					DATABLOCK1 See Parameter #1.
5	005					DATABLOCK2 See Parameter #1.
6	006					DATABLOCK3 See Parameter #1.
7	007					LOCKPANEL prevents the access to parameters from panel.
8	008				1	EEROMLOCK a nonzero will cause parameters to be stored to EEPROM.
9	009	EE				TBCTRANSMIT1 is a control word that defines the transmission intervals of I/O. (See Section 4-2.2)
10	00A	EE				TBCTRANSMIT2 as 9.
11	00B					
12	00C					RESET resets the faults when not zero.
13	00D					STATUS CMD is a centralized control word, where each bit has a different meaning as follows: DEC BIT 1 = 0 = stop with ramp 2 = 1 = stop with current limit (speed control) 4 = 2 = coast stop 64 = 6 = start to 29 / 27 128 = 7 = start to 161EE / 167EE 256 = 8 = start to 162EE / 168EE 512 = 9 = reset of faults 1024 = 10 = bypass the integrator (speed control) Note: When used, requests from other sources are ignored. STATUS CMD is cleared by RESET or by sending a zero.
14	00E					CP2 ANALOG is an input for application blocks. CP2 sends to this place its analog input.
15	00F					ANAOUT2
16	010					ANAOUT3
17	011					
18	012					
19	013					CP1 BUTTONS is the push-button data of CP1 as packed bit information sent by 1631OC. Data is decoded to discrete addresses by the CP1 BUTTONS application block.20

D	H	TYPE	MAX	MIN	INIT	NAME
20	014		0	0		SELMASTOPC is counter that increments by one for each stop request (3) received through serial channel.
21	015		0	0		DRIVESTOPC is counter that increments by one for each stop caused by the INU (e.g., a fault).
22	016					COAST STOP is coast stop command. A nonzero will stop modulation right away.
23	017					BUTTONSWORD is packed bit coded information from CP2. Used as input for application block.
24	018					START2 is start request. INU will start to FREQ1 161EE or SPEED1 167EE.
25	019					START3 is start request. INU will start to FREQ2 162EE or SPEED2 168EE.
26	01A		1400	-1400		TORQREF 1000 = Rated
27	01B		20000	-20000		SPEEDREF is a signed speed reference (speed control). 2000 = DRIVESPEEDMAX 155EE
28	01C					
29	01D		20000	-20000		FREQREF a signed frequency reference
30	01E		1000	-1000		DELTASPREF is the incremental number CP2 is sending to be added to 29. Is set to zero after adding.
31	01F		1000	-1000		DELTASPREF1 is the incremental number CP2 is sending, which is added inside application blocks.
32	020					Reserved for display message addresses between control panels and the inverter.
33	021					- " -
34	022					- " -
35	023					- " -
36	024					- " -
37	025					- " -
38	026					- " -
39	027					- " -
40	028					- " -
41	029					- " -
42	02A					- " -
43	02B					- " -
44	02C					- " -
45	02D					- " -
46	02E					DATABLOCKS4 See Parameter #1.

D	H	TYPE	MAX	MIN	INIT	NAME
47	02F					DATABLOCKS5 See Parameter #1.
48	030	EE			1	SCALARCONTROL a nonzero means the controllers are on. Zero off.
49	031	EE				FRSSPEEDSTEP is a flag to select the place where 238 is added: If 49EE is zero, step is added to speed reference before filters (55EE and 74EE). If it is nonzero, the step is added after the filters.
50	032	EE	100	0	0	KPSP Gain of speed droop feedback in .1% of load.
51	033	EE	20000	0	20000	SPEEDMAX is signed upper speed reference limit. 20000 Equals full speed as set in DRIVESPEEDMAX 155.
52	033	EE	0	-20000	-20000	SPEEDMIN is signed lower speed reference limit. Scaling same as 51EE.
53	035	EE	3600	0	20	SPEEDINTACC is ramp time of speed reference integrator in seconds from (155EE) to zero (speed control).
54	036	EE	3600	0	20	SPEEDINTDEC is ramp time of speed reference integrator in seconds from (155EE) to zero (speed control).
55	037	EE	1000	0	0	FRS is time constant of the first filter in milliseconds. 10 is the lowest value. If zero filter is not used. (Speed Control).
56	038	EE	32000	0	1500	TIS is the integral time constant for the speed controller in milliseconds.
57	039	EE	30000	0	2000	KPS is the proportional gain of the speed controller. 100 = Unity
58	03A	EE				SPEEDSOFTENTIME .1 Sec Increments (Speed Control)
59	03B	EE				KPSDTIME Gain of Accel Comp. (Speed Control)
60	03C	EE	10000	5	6000	FLYINGFREQMAX is starting frequency (positive) of flying start option.
61	03D	EE	10000	-5	-6000	FLYINGFREQMIN is starting frequency (negative) of flying start option.
62	03E	EE	20000	20000	6000	FREQMAX maximum limit of frequency reference.
63	03F	EE	20000	20000	-6000	FREQMIN minimum limit of frequency reference.
64	040	EE	6000	10	200	FREQINTACC is the ramp time in 0.1 seconds of frequency reference integrator upwards. Scale: 200 equals to 100Hz per 20 seconds.
65	041	EE		0	460	SAMI AC VOLTAGE is the rated line to line voltage of frequency converter. (volt increments)
66	042	EE	6000	10	200	FREQINTDEC is the ramp time of frequency reference integrator down. Scaling is so that 10 equals to -100Hz per second.
67	043	EE	120	0	100	MAXOUTPUTVOLTAGE is a limit for output voltage. 100 = rated output voltage.

D	H	TYPE	MAX	MIN	INIT	NAME
68	044	EE	20000	1000	6300	FIELDWEAKPNT is the frequency at which the output voltage reaches the value (67EE), if DC voltage is high enough. Defines the slope of U/f line together with 67EE. (6300 = 63Hz).
69	045	EE	20000	0	1000	IRCOMPPOINT is the frequency where the effect of IR compensation ends. (1000 = 10Hz).
70	046	EE	1200	0	0	IRCOMPCURRENT is a current reference for IR compensation. 1000 = rated.
71	047	EE			0	CONTROLSEL is a selection flag between running modes and different references
72	048	EE	180	0	0	TORQMAXTIME is the time in seconds IR compensation stays on after start. (0 = Infinity)
73	049				0	FREQDROOPING GAin of FREQDROOP Control
74	04A	EE	1000	0	0	FRS1 is the time constant in milliseconds for the second filter of speed controller.
75	04B	EE	20000	0	1000	RESTARTDELAY is the time delay in ms for a new start right after a coast stop.
76	04C	EE			0	
77	04D	EE	20000	0	100	STOP FREQ is the frequency (absolute value) where INU stops modulating after ramp stop. (100 = 1Hz.)
78	04E	EE	20000	0	0	TACHORIPPLE is a limit for TACHO FAULT. IF two successive measured speed values (21 ms) differ more than this, drive trips. A zero value disables this fault.
79	04F	EE	1400	300	1000	IREMAX is the positive limit for active component of the output current. 1000 equals 0.87 times the rated current.
80	050	EE	-300	-1400	-1000	IREMIN is the negative limit for active component of the output current. Scaling as 79EE.
81	051	EE	2000	0	300	J GAIN is number describing the inertia/slow down time of the mechanical system. Used by ride through option.
82	052	EE	3000	10	1000	STALLFREQ is highest frequency where stall protection is still active. (1000 = 10Hz.)
83	053	EE	180	1	10	STALLTIME is time delay in seconds between a stalling condition to the trip. (10 = 10 Seconds)
84	054	EE	500	0	50	FSLIPSCALE is scaling for slip compensation. (50 = .5Hz.)
85	055	EE	3	0	0	IRCOMPSEL is a selection flag for IR compensation option: 0 = off 1 = on without automatic search 3 = on with automatic search
86	056	EE	1	0	0	STALLPROTECTSEL is a selection flag for stall protection option: 0 = off 1 = 0n

D	H	TYPE	MAX	MIN	INIT	NAME
87	057	EE	1	0	0	FLYINGSTARTSEL is a selection flag for flying start option: 0 = off 1 = on
88	058	EE	1 1	0	0 0	NETFAILSEL is a selection flag for ride through option: 0 = off 1 = on
89	059	EE	1	0	0	SLIPCOMPSEL is selection flag for slip compensation: 0 = off 1 = on
90	05A	EE	1	0	0	TORQCONTSEL is selection flag for torque control option: 0 = off 1 = on
91	05B	EE	1	0	1	INTEGMODESEL is selection flag for S curve for the reference integrator: 0 = ordinary integrator 1 = S curve on
92	05C	EE	1	0	0	SPEEDCONTSEL is selection flag for speed control option: 0 = off 1 = on
93	05D	EE	1	0	1	TRENDBUFSEL is flag for trend buffers: 0 = off 1 = on
94	05E	EE	1	0	0	SPEEDMEASSEL is flag for speed measurement: 0 = off 1 = on
95	05F	EE	1	0	0	DATRANSFSEL is flag for D/A converter: 0 = off 1 = on
96 97 98	060 061 062					
99	063	EE	1	0	0	SIGN is flag, which defines the signs of the left and middle displays of CP2. 0 = sign same as the value 1 = opposite sign
100	064	EE	30000	1	1	DISPMULO is the multiplier of left display of CP2.
101	065	EE	30000	1	10	DISPDIVO is the divider of the left display of CP2.
102	066	EE	3	0	1	DISPPNTO is the number of decimals of the left display of CP2.
103	067	EE	2500	0	29	DISPSRCO is the variable to be shown on left display of CP2. The value shown in display is input value times (100EE) divided by (101EE).
104	068	EE	30000	1	1	DISPMUL1 is the multiplier of middle display of CP2.

D	H	TYPE	MAX	MIN	INIT	NAME
105	069	EE	30000	1	10	DISPDIV1 is the divider of the middle display of CP2.
106	06A	EE	3	0	1	DISPPNT1 is the number of decimals of the middle display of CP2.
107	06B	EE	2500	0	208	DISPSRC1 is the variable to be shown on middle display of CP2. The value shown in display is input value times (104EE) divided by (105EE).
108	06C	EE	30000	1	1	DISPMUL2 is the multiplier of right display of CP2.
109	06D	EE	30000	1	10	DISPDIV2 is the divider of the right display of CP2.
110	06E	EE	3	0	1	DISPPNT2 is the number of decimals of the right display of CP2.
111	06F	EE	2500	0	205	DISPSRC2 is the variable to be shown on right display of CP2. The value shown in display is input value times (108EE) divided by (109EE).
112	070		2500	0		REQUESTMSGE is a place to send an address of requested data. See Section 4-2.3
113	071					ANSWERMSGE is used by INU to respond to request. If INU gets a request of address 113, it stores the incoming value to the place, which was last requested with 112.
114	072	EE	30000	0	10	IVAL0 is time interval at which INU sends the content of location defined in 115EE. Time is multiples of 21ms. INU will not accept values that cause overloading of first channel. See Section 4-2.1.
115	073	EE	255	0	247	IXO is address of the variable to be sent with intervals of 114EE.
116	074	EE	30000	0	9	IVAL1 is like 114EE.
117	075	EE	255	0	248	IX1 is like 115EE.
118	076	EE	30000	0	9	IVAL2 is like 114EE.
119	077	EE	255	0	249	IX2 is like 115EE.
120	078	EE	30000	0	8	IVAL3 is like 114EE.
121	079	EE	255	0	15	IX3 is like 115EE.
122	07A	EE	30000	0	8	IVAL4 is like 114EE.
123	07B	EE	255	0	16	IX4 is like 115EE.
124	07C	EE	30000	0	0	IVAL5 is like 114EE.
125	07D	EE	255	0	0	IX5 is like 115EE.
126	07E	EE	30000	0	0	IVAL6 is like 114EE.
127	07F	EE	255	0	0	IX6 is like 115EE.
128	080	EE	30000	0	0	IVAL7 is like 114EE.
129	081	EE	255	0	0	IX7 is like 115EE.

D	H	TYPE	MAX	MIN	INIT	NAME
130	082	EE	30000	0	1	NORMALMSGE is the update interval for normal message sent to CP2. Scaling is by multiples of 420ms.
131	083	EE	30000	0	10	DIAGNMSGE is the update interval for diagnostic message sent to CP2. Scaling by multiples of 420ms.
132	084					
133	085					
134	086	EE	30000	0	10	IVAL0-2 is time interval at which INU sends the content of 135EE through channel 2. Time is multiples of 21ms. INU will not accept values that cause overload in the channel. See Section 4-2.1.
135	087	EE	255	0	213	IXO-2 is address of the variable to be sent with intervals of 134EE.
136	088	EE	30000	0		IVAL1-2 is like 134EE.
137	089	EE	255	0	214	IX1-2 is like 135EE.
138	08A	EE	30000	0	0	IVAL2-2 is like 134EE.
139	08B	EE	255	0	0	IX2-2 is like 135EE.
140	08C	EE	30000	0	210	IVAL3-2 is like 134EE.
141	08D	EE	255	0	0	IX3-2 is like 135EE.
142	08E	EE	30000	0	0	IVAL4-2 is like 134EE.
143	08F	EE	255	0	0	IX4-2 is like 135EE.
144	090	EE	30000	0	0	IVAL5-2 is like 134EE.
145	091	EE	255	0	0	IX5-2 is like 135EE.
146	092	EE	30000	0	0	IVAL6-2 is like 134EE.
147	093	EE	2500	0	0	IX6-2 is like 135EE, but is sent with address from 148EE.
148	094	EE	255	0	0	IXS6-2 is destination address of data.
149	095	EE	30000	0	0	IVAL7-2 is like 134EE.
150	096	EE	2500	0	0	IX7-2 is like 147EE.
151	097	EE	255	0	0	IXS7-2 is like 148EE.
152	098			0	0	KPS MIN Minimum Gain for Speed Control
153	099		500	0		KPS WEAKPNT Freq. for Max Gain of Speed Control
154	09A	EE	36	1	2	POLEPAIRS is for pole pair number of motor.
155	09B	EE	16000	100	1800	DRIVESPEEDMAX is the desired drive speed RPM, which corresponds to the value 20000.
156	09C	EE	6000	10	1024	TACHOPULSENMBR is number of pulses per revolution of the digital tachometer.

D	H	TYPE	MAX	MIN	INIT	NAME
157	09D	EE	30000	0	0	COMM TIMEOUT2 is time limit between good messages for channel 2, which is not considered as loss of communication. Scale by multiples of 21ms. The action is determined by 171EE.
158	09E	EE	10	2	8	CHARGETIME is time the copper is charged using main GTOs before inverter starts. Eight equals 800ms.
159	09F	EE	20000	0	5000	TACHOPHASEDISABLE is frequency limit. If (235) is higher than limit, only one tachometer channel is used for speed measurement. (1000 = 10 Hz)
160	0A0	EE	1	0	0	TACHOTYPE is selection flag: 0 = two channel tach. 90 degrees between channel pulses. 1 = one channel tach. (a hardware change required).
161	0A1	EE	20000	-20000	0	FREQ1 is a fixed frequency reference. INU starts towards this from 24. Scale 1000 = 10Hz,
162	0A2	EE	20000	-20000	0	FREQ2 is a fixed frequency reference. INU starts towards this from 25. Scale 1000 = 10Hz,
163	0A3					
164	0A4	EE	10	0	0	MASTERSLAVE is a mode of channel two: 0 = operates according to protocol, 2 = debugger.
165	0A5					
166	0A6	EE	0	0	2304	SCDRIVETYPW is packed bit word, which shows/defines which options are on. DEC VAL. Bit 1 0 = IR Compensation 2 1 = IR Compensation Automatic Search 4 2 = Stall Protection 8 3 = N/A 16 4 = Flying Start 32 5 = Ride Through 64 6 = Slip Compensation 128 7 = Torque Control 256 8 = Integrator with S Curve 1024 10 = Speed Control 2048 11 = Trend Buffers -32768 15 = D/A Converter
167	0A7	EE	20000	-20000	0	SPEED1 Preset Speed Ref 20000 = DRIVESPEEDMAX
168	0A8	EE	20000	-20000	0	SPEED2 Preset Speed Ref 20000 = DRIVESPEEDMAX
169	OA9					
170	0AA	EE	4800	110	4800	CH2BAUDRATE is the baud rate for channel two. When want to change: - set 8 = 1 - change 170EE and wait until message “STORED TO BACKUP/SA 51” does not show up - remove auxiliary power for 10s

D	H	TYPE	MAX	MIN	INIT	NAME
171	0AB	EE	3	0	3	SELMACONT is a flag to select the action after communication loss: 0 = no action 1 = message to panel 2 = message plus ramp stop 3 = message plus coast stop
172	0AC	EE	30000	0	238	COMM TIMEOUT is time limit between good messages for channel 1 which is not considered as loss of communication. Scale by multiples of 21 ms. The action is determined by 171EE.
173	OAD	EE	3	0	3	COMMUNICATION TYPE determines the communication mode. 0 = no acknowledge 1 = acknowledge for channel 1 2 = acknowledge for channel 2 3 = acknowledge for both channels
174	0AE	EE	3000	0	0	TACHODELAY is time for monitoring tach pulses. Pulses have to appear during this time otherwise situation is considered a fault. Delay is set in multiples of 21ms.
175	OAF					
176	0B0	M	0	0		FLT QUEUE 1 contains the newest fault number or -1 if a reset was given. All possible numbers are explained at 210..212.
177	0B1	M	0	0		FLT QUEUE 2 gets the data that was in 176 before a reset or new fault.
178	0B2	M	0	0		FLT QUEUE 3 gets the data that was in 177 before a reset or new fault.
179	0B3	M	0	0		FLT QUEUE 4 similar to 177.
180	0B4	M	0	0		FLT QUEUE 5 similar to 178.
181	0B5	M	0	0		FLT QUEUE 6 similar to 179.
182	0B6		0	0		OKMSGES 1 is number of good messages received on channel one. Increments by one for each message.
183	0B7		0	0		FAULTMSGES 1 is number of bad messages received on channel one. Should be zero. If this count increases, it means problems in communication link.
184	0B8		0	0		OKMSGES2 same as 182, but for second channel.
185	0B9		0	0		FAULTMSGES2 same as 183, but for second channel.
186	0BA	EE	2500	0	0	DA1REFADDR is address of the reference signal or constant for D/A converter channel 1.
187	0BB	EE			223	DA1ADR is address of the monitored variable.
188	0BC	EE			4	DA1SCALE scales the incoming number to eight bit.
189	0BD	EE			1	DA1MODE is mode selection: zero or nonzero.

D	H	TYPE	MAX	MIN	INIT	NAME
190	0BE	EE	500	0	50	CURRENTOFFSET is the upper limit for offset elimination. If original error tends to be bigger than limit, INU does not start and displays "FL 19/I MEAS FAULT" . 50 equals 5% of the rated current.
191	0BF	EE	2500	0	223	TREND1 is the address of variable to be saved to first trend.
192	0C0	EE	2500	0	224	TREND2 like 191.
193	0C1	EE	2500	0	225	TREND3 like 191.
194	0C2	EE	2500	0	226	TREND4 like 191.
195	0C3	EE	2500	0	215	TREND5 like 191.
196	0C4	EE	32767	0	1	TRENDIVAL sampling interval as multiples of 3ms.
197	oC5	EE	32767	0	-1	TRENDTRIG selects the triggering condition: -1 = only from faults, N = triggers if two successive values differ more than N
198	0C6					
199	0C7					TRENDSAVE a nonzero will cause a trend triggering once, then automatically resets.
200	0C8		0	0		TRIGCOUNT is to see how often triggering happens based on value of (197EE).
201	0C9		0	0		IRE FILT is filtered actual value of active component of output current. Scaling: 1000 equals to 0.87 times rated current.
202	0CA		0	0		T ACT is filtered actual value of torque. 1000 = rated below field weakening point. .1% of rated
203	0CB		0	0		P ACT is filtered actual value of active power. .1% of rated
204	0CC		0	0		U ACT is filtered actual value of output voltage. .1% of rated
205	0CD		0	0		I TOTFILT is filtered value of total output current. .1% of rated
206	0CE		0	0		COS PHI is measured value for output power factor. 1000 = unity.
207	0CF		0	0		UC ACT is filtered actual value of DC voltage. .1% of rated.
208	0D0		0	0		FR ACT is filtered value of inverter output. 1000 = 10 Hz.
209	0D1		0	0		DIRECTION is logic signal. Zero when frequency is positive and non zero when it is negative.

D	H	TYPE	MAX	MIN	INIT	NAME
210	0D2		0	0		FAULTWORD0 contains a fault or faults from hardware coded to bits as follows. A reset clears this. Numbers are the same that are shown in CP1 and 176M: Dec. Val. No. Bit 1 1 0 = Chopper Undervoltage 2 2 1 = Chopper Overvoltage 4 3 2 = Auxiliary Power Fault 8 4 3 = Overtemperature 16 5 4 = Overcurrent 32 6 5 = DC Overvoltage 64 7 6 = DC Undervoltage 256 9 8 = U1-Fault 512 10 9 = U2-Fault 1024 11 10 = V1-Fault 2048 12 11 = V2-Fault 4096 13 12 = W1-Fault 8192 14 13 = W2-Fault
211	0D3	M	0	0		FAULTWORD1 contains a fault or faults detected by software. Coding same as 210M. Dec. Val. No. Bit 1 19 0 = Current Measurement Error 2 21 1 = Matching Card Fault 4 22 2 = Processor Fault 16 15 4 = Short Circuit or Ground Fault 256 25 8 = Programmable Fault 512 26 9 = Programmable Fault 4096 17 12 = Communication Loss Ch 1 8192 17 13 = Communication Loss Ch 2 16384 20 14 = Motor Stalling -32768 18 15 = Tachometer Fault
212	0D4	M	0	0		FAULTWORD2 contains a status data. Some of them prevent running and are marked with "*". Coding similar to 210. Dec. Val. No. Bit 1 50* 0 = Empty EEPROM 2 51 1 = Writing to EEPROM 4 52 2 = Can Not Write to EEPROM. 8 53 3 = Parameter Out of Limits 16 55 4 = Can't Write to this Address 32 57* 5 = Too Low AC/DC Voltage 64 59 6 = System Restart 128 58* 7 = Starting Disabled 8192 56 13 = No Battery Backup
213	0D5					IOWORD
214	0D6		0	0		DRIVESTATUS is status word of INU. Bits 0 = Running 1 = Ready 2 = Fault Gets value 3 when INU is running.

D	H	TYPE	MAX	MIN	INIT	NAME
215	0D7		0	0		SCSTATUS is a status word of controllers. Dec. Val. BIT 1 0 = Idling 2 1 = Ride Through 4 2 = Flying Start 8 3 = Reference Integration 16 4 = IREHIGH Controller 32 5 = IRELOW Controller 64 6 = UCHIGH Controller (119%) 128 7 = UCHIGH Controller (116%) 256 8 = IR Compensation 4096 12 = Inducing Flux 8192 13 = Torque Control 16384 14 = IR Compensation at Current Limit
216	0D8					SAMIADDR
217	0D9					SAMIDATA
218	0DA		32767	-32768		UREFSTEP is an additional reference for modulator. 16125 = 100%.
219	0DB		0	0		IR instantaneous value of the R phase current. Scaling 1000 = rated current.
220	ODC		0	0		IS instantaneous value of the S phase current. Scaling 1000 = rated current.
221	0DD		0	0		ID is the active component of the current. Scaling 1000 = rated current.
222	0DE		0	0		IQ is the reactive component of the current.
223	0DF		0	0		IRE is an actual value active current. Scale 1000 = 0.87 times rated current.
224	0E0		0	0		I TOT is the total output current measurement, scale 1000 = rated.
225	0E1		0	0		FREQREF1 is frequency reference before integrator. (.01 Hz.)
226	0E2		0	0		FREQREF2 is frequency reference after integrator. The limiting controllers effect this also. (.01 Hz)
227	0E3		0	0		UCAVG, filtered actual value of DC volts. 1000 = Rated
228	0E4		0	0		ABSFREQ is nonsigned value of frequency. (.01 Hz)
229	0E5		0	0		FSLIP is output from slip compensation block (.01 Hz)
230	0E6		0	0		UREF is voltage reference for modulator. 16125 = rated
231	0E7		0	0		FRREF is the final reference to modulator.
232	0E8		0	0		SPEEDREF1 is speed ref. to integrator after selection logic. (speed control) 20000 = DRIVESPEEDMAX 155
233	0E9		0	0		SPEEDREF2 is speed reference after integrator.

D	H	TYPE	MAX	MIN	INIT	NAME
234	0EA		0	0		FREQREF3 is frequency reference created by speed regulator.
235	0EB		0	0		SPEEDACT is the measured speed. ((speed control)
236	0EC		0	0		SPEEDACT2 is filtered value of speed.
237	0ED		5000	5000		TORQSTEP is for step changes in frequency at the modulator. 1000 = 1 Hz.
238	0EE		20000	-20000	0	SPEEDSTEP is for step changes for speed reference. See 49EE.
239	0EF		0	0		FACT is calculated frequency based on measured speed. 100 = 1 Hz.
240	0F0		0	0		FSLIPREF is output from speed control.
241	0F1	EE	2500	0		227 TREND6 as 191.
242	0F2	EE	2500	0		230 TREND7 as 191.
243	0F3	EE	2500	0		231 TREND8 as 191.
244	0F4		0	0		IPEAK is the peak value of phase currents. 1000 = rated and 2300 = overcurrent tripping level.
245	0F5					DIG INPUTS is digital inputs from IOC card to application block DIGITAL INPUTS.
246	0F6					ANAIN0 is analog input from IOC card to application block ANALOG IPUT 0.
247	0F7					DIG OUTPUTS is digital output from application block DIGITAL OUTPUTS to IOC card.
248	0F8					ANAOUT0 is output from application block ANALOG OUTPUT 0 to IOC card.
249	0F9					ANAOUT1 is output from application block ANALOG OUTPUT 1 to IOC card.
250	0FA					ANAIN 1 is analog input 1 from AIO card to application block ANALOG INPUT 1.
251	0FB					ANAIN2 is analog input 2 from AIO card to application block ANALOG INPUT 2.
252	0FC	EE	2500	0	355	DA2REFADDR
253	0FD	EE	2500	0	227	DA2ADDR
254	0FE	EE			2	DA2SCALE
255	0FF	EE			1	DA2MODE
256	100					
257	101		0	0		UCVOLTAGE is the value INU is measuring for DC Voltage in volts.
258	102	EE	3000	0	0	UCMEASURED BY BUS

D	H	TYPE	MAX	MIN	INIT	NAME
259	103		0	0		UCNOMINAL is the rated value of the DC Voltage.
260	104					FIND UC OFFSET a nonzero is a start request for DC Voltage calibration.
261	105		0	0		UCOFFSET is the resulting software scale. Default is 10000 = 100%.
262	106		0	0		IROFFSET result from current offset calibration. 10 = 1%
263	107		0	0		ISOFFSET result from current offset calibration. 10 = 1%
264	108		0	0		L1STATUS is status information of the serial ch 1 hardware.
265	109		0	0		L2STATUS is status information of the serial ch 2 hardware.
266	10A		0	0		HWFAULTS1 is counter for messages with bad parity at ch 1.
267	10B		0	0		HWFAULTS2 is counter for messages with bad parity at ch 1.
268	10C		0	0		BCCERRORS1 is counter for messages with Checksum errors at ch 1.
269	10D		0	0		BCCERRORS2 is counter for messages with Checksum errors at ch 2.
270	10E		0	0		FORMATERRORS1 is counter for messages with unrecognized character errors at ch 1.
271	10F		0	0		FORMATERRORS2 is counter for messages with unrecognized character errors at ch 2.
272	110		0	0		EEPROMSUCCES is counter of successful writings into EEPROM.
273	111		0	0		EEPROMFAILED is counter of failed write attempts to EEPROM.
274	112		0	0		CURRENTBALANCE is actual value unbalance of output currents. 10 equals 1% from rated current.
275	113	EE	3000	50	100	E S LIMIT is tripping limit for ground and short circuit currents during start up. 1000 = 10% of INU Rating.
276	114	EE	1000	1	50	UCFILT FTR is the filtering time constant of DC Voltage measurement in milliseconds.
277	115		0	0		UCFILT is filtered actual value DC Voltage. 1000 equals rated value.
278	116		0	0		UC is the actual value of DC Voltage from A/D converter with the scale 178 equals rated.
279	117		0	0		IA is current at X/Y coordinates.
280	118		0	0		IB is current at X/Y coordinates.

D	H	TYPE	MAX	MIN	INIT	NAME
281	119		0	0		INTDIRECTION is the direction of ref integrator and gets these values: 0 = no integration 1 = the absolute frequency is increasing. 2 = the absolute frequency is decreasing.
282	11A		0	0		UCEMF is correction to voltage reference due to DC voltage.
283	11B		0	0		UFIRUREF is the output of maximum selector of the voltage reference.
284	11C		0	0		NORMALUREF is the output of minimum selector of the voltage reference.
285	11D		0	0		SCALEDMAXVOLTAGE is the maximum voltage reference to modulator. 16125 = 100%.
286	11E		0	0		EMFVECTOR is basic voltage reference. 16125 = 100%.
287	11F		0	0		UFIR is voltage reference from IR compensation. 16125 = 100%.
288	120		0	0		FLSTARTUREF is voltage reference from flying start. 16.25 = 100%
289	121					
290	122					
291	123					
292	124					
293	125					
294	126					
295	127		0	0		ROWSPEEDREF2 Speed Ref. after integrator 20000 = DRIVESPEEDMAX 155EE
296	128		0	0		DROOPING Frequency reduction due to torque increase. 200 = 1%
297	129		0	0		ACC COMP Slip increase for accelerating torque
298	12A		0	0		FREQDROOP Same as 296 except in freq. control
299	12B					
300	12C	EE	500	0	80	SPEEDSLIPMAX Max Slip in SPEED CONTROL
301	12D	EE	0	-500	-80	SPEEDSLIPMIN Minimum Slip in Speed Control
302	12E					
303	12F		0	0		SAMIDATA is data of the latest message from ch 1 with no format errors.
304	130		0	0		SAMIADR is address for above.
305	131			0		SAMIDATA1 is data of the latest message from ch 1 which is checked and accepted.

D	H	TYPE	MAX	MIN	INIT	NAME
306	132		0	0		SAMIADR1 is address for above.
307	133		0	0		SAMIDATA2 is data of the latest message at ch 1 with no format errors.
308	134		0	0		SAMIADR2 is address for above
309	135		0	0		SAMIDATA3 same as 303 but for ch 2.
310	136		0	0		SAMIADR3 same as 306 but for ch 2.
311	137		0	0		NEGNTACHO is counter for negative tachometer pulses.
312	138		0	0		POSNTACHO is counter for positive tachometer pulses.
313	139					
314	13A					
315	13B					
316	13C					
317	13D					
318	13E					
319	13F					
320	140		0	0		TREND1 FETCH gets the value of all 100 samples of first trend continuously. One sample value stays 210ms. When softwired to D/A converter trends can be monitored with scope or recorder.
321	141		0	0		TREND2 FETCH as 320 but for 2. trend.
322	142		0	0		TREND3 FETCH as 320 but for 3. trend.
323	143		0	0		TREND4 FETCH as 320 but for 4. trend.
324	144		0	0		TREND5 FETCH as 320 but for 5. trend.
325	145		0	0		TREND6 FETCH as 320 but for 6. trend.
326	146		0	0		TREND7 FETCH as 320 but for 7. trend.
327	147		0	0		TREND8 FETCH as 320 but for 8. trend.
328	148					
329	149					
330	14A		0	0	30	DEVICETYPE is type of the drive. 30 means a scalar control INU.
331	14B		0	0	303	REVISION is the revision number of the software/memories. 303 equals 3.03.
332	14C		0	0	5601	EPROM-D17 is Stromberg code for memory D17 four highest numbers.
333	14D		0	0	7542	EPROM-D17 is Stromberg code for memory D17 four lowest numbers.

D	H	TYPE	MAX	MIN	INIT	NAME
334	14E		0	0	5601	EPROM-D18 is Stromberg code for memory D17 four highest numbers.
335	14F		0	0	7551	EPROM-D18 is Stromberg code for memory D17 four lowest numbers.
336	150		0	0		PARCOUNT gets the value of highest address number used by application blocks plus one.
337	151					
338	152					
339	153					
340	154					
341	155					
342	156					
343	157					
344	158					
345	159					
346	15A					
347	15B					
348	15C					
349	15D					
350	15E					
351	15F	EE	2000	0	100	KP IRE is the P-gain for torque limiting controllers.
352	160	EE	1000	0	80	TI IRE is the I-term for torque limiting controllers.
353	161		10000	0	2000	STATORRESISTANCE Motor Stator resistance for regen. torque limit correction
354	162	EE	1500	1100	1190	UCHIGH is the limit for the Uc "higher" controller. 1000 = rated. DC Voltage
355	163	EE	1500	1100	1160	UCHIGHREF is the limit for the Uc "lower" controller. 1000 = rated. DC Voltage
356	164	EE	1050	1000	1010	KP UCHIGH is the gain of the "higher" Uc controller.
357	165	EE	6000	0	3000	KP UCHIGHREF is the gain of the "lower" Uc controller.
358	166	EE	50	1	2	KP INCREMENT, increment of gain of "lower" Uc controller in transition from "higher" to "lower"
359	167	EE	4000	-4000	200	IRESTABGAIN VP1 is gain of the torque stabilization at approx. 60...200Hz.
360	168	EE	4000	-4000	500	IRESTABGAIN VP3 as 359, but 36...60Hz.
361	169	EE	4000	-4000	800	IRESTABGAIN VP5 as 359, but 25...36Hz.

D	H	TYPE	MAX	MIN	INIT	NAME
362	16A	EE	4000	-4000	1000	IRESTABGAIN VP5 as 359, but 20...25HZ.
363	16B	EE	4000	-4000	800	IRESTABGAIN VP9 as 359, but 10...20Hz.
364	16C	EE	4000	-4000	1000	IRESTABGAIN VP11 as 359, but 0...10Hz.
365	16D	EE	998	0	950	IRESTABFACTOR is time constant for torque stabilization.
366	16E					
367	16F	EE	2000	0	1000	FLUXSTABGAIN is flux stabilization gain at 0...20Hz.
368	170	EE	998	0	950	FLUXSTABFACTOR is the time constant for above.
369	171					
370	172	EE	10000	0	2000	UCSTABGAIN is the Uc stabilization gain.
371	173	EE	998	0	850	UCSTABFACTOR is the time constant for above.
372	174					
373	175					
374	176					
375	177					
376	178					
377	179					
378	17A		0	0		
379	17B					TORQCONTOUT Frequency output of torque control.
380	17C		0	0		IRECONTOUT is the output frequency of the torque limiting controllers.
381	17D		0	0		UCCONTOUT is the output frequency of Uc high controller.
382	17E		0	0		TORQMAXCONTOUT is the output frequency of the IR compensation/torque maximization.
383	17F		0	0		NETFAILCONTOUT is the output frequency of the ride through controller.
384	180		0	0		FLYINGCONTOUT is the output frequency of the flying start controller.
385	181		0	0		FREQIRESTAB is the output frequency of the torque stabilization.
386	182		0	0		FREQUCSTAB is the output frequency of the Uc stabilization.
387	183		0	0		UREFSTAB is the output voltage reference of the flux stabilization.
388	184					
389	185					

D	H	TYPE	MAX	MIN	INIT	NAME
390	186		2000	0	250	KP _ TORQUE P _ GAIN of Torque Controller
391	187		10000	0	150	TI _ TORQUE I _ GAIN of Torque Controller
392	188					
393	189					
394	18A					
395	18B					
396	18C					
397	18D		0	0		I PEAKCOUNT Count of times current was over 230% of rated.
398	18E					
399	18F					
400	190					
401	191					
402	192					
403	193					
404	194					
405	195	EE			1	LEARNMODE is selection flag for IR compensation: 1 = automatic search at every start. The result is saved. 0 = the value in memory is used.
406	196	EE	800	0	300	GEN _ IRCOMPPOINT is frequency limit for IR Compensation.
407	197	EE	20000	0	500	IRCOMPLIMIT is frequency limit between IPEAK control and IRE control. (500 = 5 Hz)
408	198	EE	10	1	1	IRFLUXSPEED is speed of voltage reference changes during IR compensation.
409	199		0	0		AUTOTORQMAX is the voltage reference searched by auto maximization.
410	19A		0	0		IRLEVEL is voltage reference required to generate current (70EE). 161 = 1%.
411	19B	EE	500	0	80	SLIPFREQ is for the rated slip of the motor converted to stator frequency. Scale like other frequencies.
412	19C		0	0		IRCOMP is the voltage reference requested by IR compensation at zero frequency.
413	19D		0	0		IRCOMP2 is the voltage reference requested by IR compensation at zero frequency and after ramp limiting.
414	19E	EE	10	1	3	FLUXTIME is time in seconds for IR compensation to induce the flux.

D	H	TYPE	MAX	MIN	INIT	NAME
415	19F	EE	5000	50	1000	KP IRCOMP is the P gain of flux controller of IR compensation.
416	1A0	EE	1000	10	100	TI IRCOMP is the I term of the flux controller of IR compensation.
417	1A1	EE	30000	100	2000	TORQMAX P is the gain of peak current controller.
418	1A2		0	0		IPEAK AD is the measured actual value of peak current at A/D converter. Scaling so that overcurrent limit is approx. 200.
419	1A3	EE	200	100	160	IPEAKLIMIT is the limit value for peak current controller. (100 = Rated Current)
420	1A4					
421	1A5					
422	1A6					
423	1A7	EE	400	0	70	PWDNSLIPGAIN is term for removing slip. Higher slip higher number.
424	1A8		0	0		PWDNSLIPREDUCE is frequency representing slip.
425	1A9					
426	1AA	EE	30000	10	10000	PWDNFREQDEC is the base ramp value for decreasing frequency.
427	1AB	EE	5000	0	2000	PWDN UCCONTROL GAIN is P gain for Uc control during ride through.
428	1AC	EE	10000	0	4000	PWDN DGAIN is D gain.
429	1AD	EE	999	0	850	PWDN FACTOR is the time constant multiplier.
430	1AE	EE	30000	100	1100	PWDNTIME is the time limit for ride through control. Drive starts to accel to original frequency after this time. 1000 = 1 second.
431	1AF	EE	5000	0	2200	PWDNPOWEROFF is multiplier for removing power in the beginning of power outage.
432	1B0	EE	1000	10	60	UCTRESHOLD is the maximum increase rate of Uc at power up.
433	1B1	EE	1100	700	825	PWDN_UCALARM is the triggering level of the ride through control.
434	1B2		0	0		PWDN_UCREF is the reference for Uc.
435	1B3		0	0		PWDNACTIVE is a status flag of ride through control, zero off, nonzero on.
436	1B4		0	0		PWDN UCALARM TO AD the triggering limit at A/D converter.
437	1B5					
438	1B6		0	0		PWDNSUCCES is an average value of the error of Uc compared to reference. Positive or negative.

D	H	TYPE	MAX	MIN	INIT	NAME
439	1B7		0	0		NETFAILCOUNTER is counter for power outages.
440	1B8					
441	1B9					
442	1BA					
443	1BB					
444	1BC					
445	1BD					
446	1BE					
447	1BF					
448	1C0					
449	1C1					
450	1C2					
451	1C3	EE	1	0	1	D SEL is for the type of D/A converter: 0 = 2 channel and 1 = 4 channel (154DAC).
452	1C4	EE	2500	0	0	D A3REFADR is address of the reference signal or constant for D/A converter channel 3.
453	1C5	EE	2500	0	224	D A3ADR is address of the monitored variable.
454	1C6	EE			3	D A3SCALE scales the incoming number to eight bit.
455	1C7	EE			1	D A3MODE is mode selection: zero or nonzero.
456	1C8	EE	2500	0	0	D A4REFADR is address of the reference signal or constant for D/A converter channel 4.
457	1C9	EE	2500	0	231	D A4ADR is address of the monitored variable.
458	1CA	EE			6	D A4SCALE scales the incoming number to eight bit.
459	1CB	EE			1	D A4MODE is mode selection: zero or nonzero.
460	1CC					
461	1CD					
462	1CE					
463	1CF					
464	1D0					
465	1D1					
466	1D2					
467	1D3					
468	1D4	EE	2000	0	100	IRETRESHOLD is the level for minimum IRE. 100 = 1%

D	H	TYPE	MAX	MIN	INIT	NAME
469	1D5	EE	200	0	0	ZEROVOLTAGE is the voltage level at zero frequency. 10 = 1%
470	1D6	EE	5000	100	2000	FLYINGFLUXSPEED is the time of voltage rise when right frequency is found. 2000 = 2s.
471	1D7		0	0		FLSTARTACTIVE is the status of flying start: 0 = Not Active 2 = Search in Positive Direction 4 = Approx. 15% Voltage 6 = Decrease of Frequency 8 = Increasing Voltage to Normal 10 = Search in Neg. Direction 12 = Approx. 15% Voltage 14 = Decreasing Frequency 16 = Flying Start with Tach
472	1D8	EE	40	10	15	FLSTARTVOLTAGE is voltage reference 15 = 15%.
473	1D9	EE	600	5	300	FLYINGFREQLIMIT is the limit of absolute frequency under which the flying start does not search.
474	1DA	EE	600	50	200	FLYINGGAIN is the speed of search.
475	1DB		100	0	20	FLYING IRE LIMIT motor speed reached when active current is less than Parameter 475. 20 = 20%
476	1DC					
477	1DD					
478	1DE					
479	1DF		0	0		IREC Active current generated in motor.
480	1E0					
481	1E1		0	0		ID FILT filtered Active Current.
482	1E2		0	0		IQ FILT Filtered Reactive Current
483	1E3		0	0		IREMAX1 is the value the active current limiter for positive side.
484						
485	1E5	EE	10	0	4	IREFTR FAST is filtering time constant during flying start and ride through. 5 = 15ms.
486	1E6	EE	100	10	10	IREFTR SLOW is filtering time constant during normal running. 30 = 90ms.
487	1E7	EE	10000	1000	2000	INTEGUP is a gain of ref integrator S curve when it is integrating upwards.
488	1E8	EE	10000	100	2000	INTEGDOWN is a gain of ref integrator S curve when it is integrating down.
489	1E9	EE	300	0	200	HIGHVOLTAGEHYST is the hysteresis of minimum pulse over voltages higher than 83%. 100 = one minimum pulse.

D	H	TYPE	MAX	MIN	INIT	NAME
490	1EA		0	0		HIGHVOLTAGE is status of the hysteresis of minimum pulse: 200 = ref over 83%, 0 = ref under 83%.
491	1EB		0	0		TD1 is a time value of modulator.
492	1EC		0	0		TD2 is a time value of modulator.
493	1ED		0	0		TD3 is a time value of modulator.
494	1EE		0	0		MODULSYNC is a flag of modulation: 255 = synchronized, 0 = asynchronized.
495	1EF		0	0		MODULTYPE is flag of modulation: 255 = higher, 0 = lower modulation.
496	1F0		0	0		VPACT is the slice number of modulator: 11, 9, 7, 5, 3 and 1.
497	1F1		0	0		SLIPTIME is an internal measuring point.
498	1F2		0	0		ANGLE is the angle of the voltage vector.
499	1F3		0	0		FULLVOLTAGE is a flag of modulator: 200 = maximum voltage, 0 = lower.
500	1F4	M	0	0		TRENDBUF1 trendbuffer samples
599	257	M	0	0		
600	258	M	0	0		TRENDBUF2
699	2BB	M	0	0		
700	2BC	M	0	0		TRENDBUF3
799	31F	M	0	0		
800	320	M	0	0		TRENDBUF4
899	383	M	0	0		
900	384	M	0	0		TRENDBUF5
999	3E7	M	0	0		
1000	3E8	M	0	0		TRENDBUF6
1099	446	M	0	0		
1100	447	M	0	0		TRENDBUF7
1199	4AF	M	0	0		
1200	4B0	M	0	0		TRENDBUF8
1299	513	M	0	0		

Extended Parameter List

An extended list of additional parameters above 1299 with only their assigned name is provided in the following table.

Number	Name	Number	Name	Number	Name
1300	DIN0_DIN	1328	DOUT4_VALUE	1434	OUT_NOT4
1301	DIN1_DIN	1329	DOUT5_VALUE	1435	IN1_OR0
1302	DIN2_DIN	1330	DOUT6_VALUE	1436	IN2_OR0
1303	DIN3_DIN	1331	DOUT7_VALUE	1437	IN_ABS3
1304	DIN4_DIN	1332	MAX_AIN0	1438	OUT_ABS3
1305	DIN5_DIN	1333	MIN_AIN0	1439	OUT_OR0
1306	DIN6_DIN	1334	OUT_AIN0	1440	NI_OR1
1307	DIN7_DIN	1335	IN_AOUT0	1441	IN2_OR1
1308	MAX_AIN1	1336	MUL_AOUT0	1442	CLK_JKFF2
1309	MIN_AIN1	1337	DIV_AOUT0	1443	OUT_JKFF2
1310	OUT_AIN1	1338	MODE_AOUT0	1444	OUT_OR1
1311	OUT_0R4	1339	IN_AOUT1	1445	IN1_MNMX0
1312	MAX_AIN2	1340	MUL_AOUT1	1446	IN2_MNMX0
1313	MIN_AIN2	1341	DIV_AOUT1	1447	OUT_MNMX0I
1314	OUT_AIN2	1342	MODE_AOUT1	1448	MODE_MNMX0
1316	DUOT0_DOUT	1343	START_CP1	1449	NOUT_JKFF2
1317	DOUT1_DOUT	1344	STOP_CP1	1450	IN1_MNMX1
1318	DOUT2_DOUT	1345	+_CP1	1451	IN2_MNMX1
1319	DOUT3_DOUT	1425	IN_NOT0	1452	OUT_MNMX1
1320	DOUT4_DOUT	1426	OUT_NOT0	1453	MODE_MNMX
1321	DOUT5_DOUT	1427	IN_NOT1	1454	IN_INT1
1322	DOUT6_DOUT	1428	OUT_NOT1	1455	IN1_SEL0
1323	DOUT7_DOUT	1429	IN_NOT2	1456	IN2_SEL0
1324	DOUT0_VALUE	1430	OUT_NOT2	1457	SEL_SEL0
1325	DOUT1_VALUE	1431	IN_NOT3	1458	OUT_SEL0
1326	DOUT2_VALUE	1432	OUT_NOT3	1459	RES_INT1
1327	DOUT3_VALUE	1433	IN_NOT4	1460	PASS_INT1

Number	Name	Number	Name	Number	Name
1461	MAX_INT1	1495	REF_Pi0	1527	OUT_ADD0
1462	MIN_INT1	1496	ACT_PI0	1528	IN1_MUL7
1463	TACC_INT1	1497	OUT_PI0	1529	IN2_MUL7
1464	TDEC_INT1	1498	P_PI0	1530	IN1_ADD1
1465	IN1_COMP0	1499	I_PI0	1531	IN2_ADD1
1466	IN2_COMP0	1500	MAX_PI0	1532	OUT_ADD1
1467	OUT_COMP0	1501	MIN_P10	1533	OUT_MUL7
1468	HYST_COMP0	1502	RES_PI0	1534	INI_FIL1
1469	OUT_INT1	1503	ERRMAX_P10	1535	IN1_MUL0
1470	IN1_COMP1	1504	ERRMIN_P10	1536	IN2_MUL0
1471	IN2_COMP2	1505	IN1_MUL4	1537	OUT_MUL0
1472	OUT_COMP1	1506	IN2_MUL4	1538	OUT_FIL1
1473	HYST_COMP1	1507	OUT_MUL4	1539	TIME_FIL1
1475	IN1_COMP2	1508	IN1_MUL5	1540	IN1_MUL1
1476	IN2_COMP2	1509	IN2_MUL5	1541	IN2_MUL1
1477	OUT_COMP2	1510	IN_INT0	1542	OUT_MUL1
1478	HYST_COMP2	1511	OUT_INT0	1543	CLK_JKFF5
1479	CLK_JKFF3	1512	RES_INT0	1544	OUT_JKFF5
1480	IN1_COMP3	1513	PASS_INT0	1545	IN_SCL0
1481	IN2_COMP3	1514	MAX_INT0	1546	OUT_SCL0
1482	OUT_COMP3	1515	MIN_INT0	1547	MUL_SCL0
1483	HYST_COMP3	1516	TACC_INT0	1548	DIV_SCL0
1484	OUT_JKFF3	1517	TDEC_INT0	1549	NOUT_JKFF5
1485	IN1_COMP4	1518	OUT_MUL5	1550	IN_SCL1
1486	IN2_COMP4	1519	OUT_MUL6	1551	OUT_SCL1
1487	OUT_COMP4	1520	IN_FIL0	1552	MUL_SCL1
1488	HYST_COMP4	1521	OUT_FIL0	1553	DIV_SCL1
1489	NOUT_JKFF3	1522	TIME_FIL0	1555	MUL_DSP0
1490	IN1_COMP5	1523	IN1_MUL6	1556	DIV_SDP0
1491	IN2_COMP5	1524	IN2_MUL6	1557	POINT_DSP0
1492	OUT_COMP5	1525	IN1_ADD0	1558	MUL_DSP1
1493	HYST_COMP5	1526	IN2_ADD0	1559	DIV_DSP1

Number	Name	Number	Name	Number	Name
1560	POINT_DSP1	1592	OUT_DLY1	1624	SEL_UPDN
1561	MUL_DSP2	1593	TIME_DLY1	1625	ZERO-UPDN
1562	DIV_DSP2	1594	IN_DLY2	1626	OUT_UPDN
1563	POINT_DSP2	1595	OUT_DLY2	1627	DELTA1_UPDN
1564	MUL_DSP3	1596	TIME_DLY3	1628	DELTA2_UPDN
1565	DIV_DSP3	1597	IN_DLY3	1639	MAX_UPDN
1566	POINT_DSP3	1598	OUT_DLY3	1630	MIN_UPDN
1567	MUL_DSP4	1599	TIME_DLY3	1631	CLK_JKFF0
1568	DIV_DSP4	1600	S_SRFF2	1632	OUT_JKFF0
1569	POINT_DSP4	1601	R_SRFF2	1633	NOUT_JKFF0
1570	D1SOURCE_DSP	1602	0UT_SRFF2	1634	CLK_JKFF1
1571	D2SOURCE_DSP	1603	NOUT_SRFF2	1635	OUT_JKFF1
1572	D3SOURCE_DSP	1604	S_SRFF3	1636	NOUT_JKFF1
1573	D4SOURCE_DSP	1605	R_SRFF3	1637	IN1-ADD2
1574	OUT_DSP0	1606	OUT_SRFF3	1638	IN2_ADD2
1575	DIS25_DSP	1607	NOUT_SRFF3	1639	OU5_ADD3
1576	DIS26_DSP	1608	IN_NOT5	1640	IN1_ADD3
1577	DISPLAY_DSP	1609	OUT_NOT5	1641	IN2_ADD3
1578	ACTIVE_DSP	1610	IN_NOT6	1642	OUT_ADD3
1579	REMIND_DSP	1611	OUT_NOT6	1643	IN1-MUL2
1580	1580_CNST	1612	IN_NOT7	1644	IN2_MUL2
1581	1581_CNST	1613	OUT_NOT7	1645	OUT_MUL2
1582	1582_CNST	1614	IN1_SEL1	1646	IN1-MUL3
1583	1583_CNSTt	1615	IN2_SEL1	1647	IN2_MUL3
1584	1584_CNST	1616	SEL_SEL1	1648	OUT_MUL3
1585	1585_CNST	1617	OUT_SEL1	1649	IN1_SEL3
1586	1586_CNST	1618	IN1_SEL2	1650	IN2_SEL3
1587	1587_CNST	1619	IN2_SEL2	1651	SEL_SEL3
1588	1588_CNST	1620	SEL_SEL2	1652	OUT_SEL3
1589	1589_CNST	1621	OUT_SEL2	1653	IN1_SEL4
1590	1590_CNST	1622	UP_UPDN	1654	IN2_SEL4
1591	IN_DLY1	1623	DOWN_UPDN	1655	SEL_SEL4

Number	Name	Number	Name	Number	Name
1655	SEL_SEL4	1687	PFCOUT_PFC	1719	RESET_CP2
1656	OUT_SEL4	1688	PFCOUT1_PFC	1720	DOUT0_CP2
1657	IN1_AND2	1689	PFCOUT2_PFC	1721	DOUT1_CP2
1658	IN2_AND2	1690	PFCOUT3_PFC	1722	DOUT2_CP2
1659	OUT_AND2	1691	PFCOUT4_PFC	1723	DOUT3_CP2
1660	IN1_AND3	1692	PFCOUT5_PFC	1736	OUT_CP2ADD
1661	IN2_AND3	1693	FLIMT1_PFC	1737	IN1_SEL5
1662	OUT_AND3	1694	FLIMIT2_PFC	1738	IN2_SEL5
1663	IN1_OR2	1695	FLIMIT3_PFC	1739	SEL_SEL5
1664	IN2_OR2	1696	FLIMIT4_PFC	1740	OUT_SEL5
1665	OUT_OR2	1697	FLIMIT5_PFC	1741	IN1_SEL6
1666	IN1_OR3	1698	SUBDELTA1_PFC	1742	IN2_SEL6
1667	IN2_OR3	1699	SUBDELTA2_PFC	1743	SEL_SEL6
1668	OUT_OR3	1700	SUBDELTA3_PFC	1744	OUT_SEL6
1669	IN_LIM0	1701	SUBDELTA4_PFC	1745	IN1_SEL7
1670	OUT_LIM0	1702	SUBDELTA5_PFC	1746	IN2_SEL7
1671	MIN_LIM0	1703	HYST1_PFC	1747	SEL_SEL7
1672	MAX_LIM0	1704	HYST2_PFC	1748	OUT_SEL7
1673	IN_LIM1	1705	HYST3_PFC	1749	IN1_SEL8
1674	OUT_LIM1	1706	HYST4_PFC	1750	IN2_SEL8
1675	MIN_LIM1	1707	HYST5_PFC	1751	SEL_SEL8
1676	MAX_LIM1	1708	F0-CP2	1752	OUT_SEL8
1677	DISMARK_DSP0	1709	START_CP2	1753	IN-SCL2
1678	DISMARK_DSP1	1710	STOP_CP2	1754	OUT_SCL2
1679	DISMARK_DSP2	1711	+_CP2	1755	MUL_SCL2
1680	DISMARK_DSP3	1712	+/-cp2	1756	DIV_SCL2
1681	DISMARK_DSP4	1713	-_CP2	1757	IN_SCL3
1682	MIN_DSP0	1714	F1_CP2	1758	OUT_SCL3
1683	MAX_DSP0	1715	F2_CP2	1759	MUL_SCL3
1684	MAX_CP2ADD	1716	F3_CP2	1760	DIV_SCL3
1685	MIN_CP2ADD	1717	PAR_CP2	1761	IN_SCL4
1686	IN1_PFC	1718	CTRL_CP2	1762	OUT_SCL4

Number	Name	Number	Name	Number	Name
1763	MUL_SCL4	1826	SAMITABLE26	1858	SAMITABLE58
1764	DIV_SCL4	1827	SAMITABLE27	1859	SAMITABLE59
1765	IN_SCL5	1828	SAMITABLE28	1860	SAMITABLE60
1766	OUT_SCL5	1829	SAMITABLE29	1861	SAMITABLE61
1767	MUL_SCL5	1830	SAMITABLE30	1862	SAMITABLE62
1768	DIV_SCL5	1831	SAMITABLE31	1863	SAMITABLE63
1800	PROGENABLE	1832	SAMITABLE32	1864	SAMITABLE64
1801	SAMITABLE1	1833	SAMITABLE33	1865	SAMITABLE65
1802	SAMITABLE2	1834	SAMITABLE34	1866	SAMITABLE66
1803	SAMITABLE3	1835	SAMITABLE35	1867	SAMITABLE67
1804	SAMITABLE4	1836	SAMITABLE36	1868	SAMITABLE68
1805	SAMITABLE5	1837	SAMITABLE37	1869	SAMITABLE69
1806	SAMITABLE6	1838	SAMITABLE38	1870	SAMITABLE70
1807	SAMITABLE7	1839	SAMITABLE39	1871	SAMITABLE71
1808	SAMITABLE8	1840	SAMITABLE40	1872	SAMITABLE72
1809	SAMITABLE9	1841	SAMITABLE41	1873	SAMITABLE73
1810	SAMITABLE10	1842	SAMITABLE42	1874	SAMITABLE74
1811	SAMITABLE11	1843	SAMITABLE43	1875	SAMITABLE75
1812	SAMITABLE12	1844	SAMITABLE44	1876	SAMITABLE76
1813	SAMITABLE13	1845	SAMITABLE45	1877	SAMITABLE77
1814	SAMITABLE14	1846	SAMITABLE46	1878	SAMITABLE78
1815	SAMITABLE15	1847	SAMITABLE47	1879	SAMITABLE79
1816	SAMITABLE16	1848	SAMITABLE48	1880	SAMITABLE80
1817	SAMITABLE17	1849	SAMITABLE49	1900	FAST-PROGENABLE
1818	SAMITABLE18	1850	SAMITABLE50	1901	FASTSAMITABLE1
1819	SAMITABLE19	1851	SAMITABLE51	1902	FASTSAMITABLE2
1820	SAMITABLE20	1852	SAMITABLE52	1903	FASTSAMITABLE3
1821	SAMITABLE21	1853	SAMITABLE53	1904	FASTSAMITABLE4
1822	SAMITABLE22	1854	SAMITABLE54	1905	FASTSAMITABLE
1823	SAMITABLE23	1855	SAMITABLE55	1906	FASTSAMITABLE
1824	SAMITABLE24	1856	SAMITABLE56	1907	FASTSAMITABLE
1825	SAMITABLE25	1857	SAMITABLE57	1908	FASTSAMITABLE

Number	Name	Number	Name	Number	Name
1910	FASTSAMITABLE	1950	BIT0_UNPK	1982	SEL_SEL11
1911	FASTSAMITABLE	1951	BIT1_UNPK	1983	OUT_SEL11
1912	FASTSAMITABLE	1952	BIT2_UNPK	1984	IN1_SEL12
1913	FASTSAMITABLE	1953	BIT3_UNPK	1985	IN2_SEL12
1914	FASTSAMITABLE	1954	BIT4_UNPK	1986	SEL_SEL12
1915	FASTSAMITABLE	1955	BIT5_UNPK	1987	OUT_SEL12
1916	FASTSAMITABLE	1956	BIT6_UNPK	1988	IN1_SEL13
1917	FASTSAMITABLE	1957	BIT7_UNPK	1989	IN2_SEL13
1918	FASTSAMITABLE	1958	BIT8_UNPK	1990	SEL_SEL13
1919	FASTSAMITABLE	1959	BIT9_UNPK	1991	OUT_SEL13
1920	FASTSAMITABLE	1960	BIT10_UNPK	1992	IN1_4SEL0
1921	FASTSAMITABLE	1961	BIT11_UNPK	1993	IN2_4SEL0
1922	FASTSAMITABLE	1962	BIT12_UNPK	1994	IN3_SEL0
1923	FASTSAMITABLE	1963	BIT13_UNPK	1995	IN4_SEL0
1924	FASTSAMITABLE	1964	BIT14_UNPK	1996	SEL1_4SEL0
1925	FASTSAMITABLE	1965	BIT15_UNPK	1997	SEL2_4SEL0
1926	FASTSAMITABLE	1966	IN_FIL2	1998	OUT_4SEL0
1927	FASTSAMITABLE	1967	OUT_FIL2	2000	2000_CNST
1928	FASTSAMITABLE	1968	TIME_FIL2	2001	2001_CNST
1929	FASTSAMITABLE	1969	IN_FIL3	2002	2002_CNST
1930	FASTSAMITABLE	1970	OUT_FIL3	2003	2003_CNST
1931	FASTSAMITABLE	1971	TIME_FIL3	2004	2004_CNST
1932	FASTSAMITABLE	1972	IN1-SEL9	2005	2005_CNST
1933	FASTSAMITABLE	1973	IN2_SEL9	2006	2006_CNST
1934	FASTSAMITABLE	1974	SEL_SEL9	2007	2007_CNST
1935	FASTSAMITABLE	1975	OUT_SEL9	2008	2008_CNST
1936	FASTSAMITABLE	1976	IN1_SEL10	2009	2009_CNST
1937	FASTSAMITABLE	1977	IN2_SEL10	2010	S8_XFR
1938	FASTSAMITABLE	1978	SEL_SEL10	2011	D8_XFR
1939	FASTSAMITABLE	1979	OUT_SEL10	2012	S9_XFR
1940	FASTSAMITABLE	1980	IN1_SEL11	2013	D9_XFR
1949	IN_UNPK	1981	IN2_SEL11	2014	S10_XFR

Number	Name	Number	Name	Number	Name
2015	D10_XFR	2049	AOUT_AOUT3	2081	IN1_AND8
2016	S11_XFR	2050	MUL_AOUT3	2082	IN2_AND8
2017	D11_XFR	2051	DIV_AOUT3	2083	OUT_AND8
2018	S12_XFR	2052	MODE_AOUT3	2084	IN1_AND9
2019	D12_XFR	2053	IN_NOT8	2085	IN2_AND9
2020	S13_XFR	2054	OUT_NOT8	2086	OUT_AND9
2021	D13_XFR	2055	IN_NOT9	2087	IN1_AND10
2022	S14_XFR	2056	OUT_NOT9	2088	IN2_AND10
2023	D14_XFR	2057	IN_NOT10	2089	OUT_AND10
2024	S15_XFR	2058	OUT_NOT10	2090	IN1_AND11
2025	D15_XFR	2059	IN_NOT11	2091	IN2_AND11
2026	XIN_FCT	2060	OUT_NOT11	2092	OUT_AND11
2027	YOUT_FCT	2061	IN_NOT12	2093	IN1_AND12
2028	X1-FCT	2062	OUT_NOT12	2094	IN2_AND12
2029	Y1_FCT	2063	IN_NOT13	2095	OUT_AND12
2030	X2_FCT	2064	OUT_NOT13	2096	IN1_AND13
2031	Y2_FCT	2065	IN_NOT14	2097	IN2_AND13
2032	X3_FCT	2066	OUT_NOT14	2098	OUT_AND13
2033	X3_FCT	2067	IN_NOT15	2099	IN1_AND14
2034	X4_FCT	2068	OUT_NOT15	2100	IN2_AND14
2035	Y4_FCT	2069	IN1_AND4	2101	OUT_AND14
2036	X5_FCT	2070	IN2_AND4	2102	IN1_AND15
2037	Y5_FCT	2071	OUT_AND4	2103	IN2_AND15
2038	IN1_4OR0	2072	IN1_AND5	2104	OUT_AND15
2039	IN2_4OR0	2073	IN2_AND5	2105	IN1_OR6
2040	IN3_4OR0	2074	OUT_AND5	2106	IN2_OR6
2041	IN4_4OR0	2075	IN1_AND6	2107	OUT_OR6
2042	OUT_4OR0	2076	IN2_AND6	2108	IN1-OR7
2045	AOUT_AOUT2	2077	OUT_AND6	2109	IN2_OR7
2046	MUL_AOUT2	2078	IN1_AND7	2110	OUT_OR7
2047	DIV_AOUT2	2079	IN2_AND7	2111	IN1_OR8
2048	MODE_AOUT2	2080	OUT_AND7	2112	IN2_OR8

Number	Name	Number	Name	Number	Name
2113	OUT_OR8	2145	S_SRFF6	2177	TIME1_1SHT1
2114	IN1_OR9	2146	R_SRFF7	2178	TIME2_1SHT1
2115	IN2_OR9	2147	OUT_SRFF6	2179	STORE1
2116	OUT_OR9	2148	NOUT_SRFF6	2180	STORE2
2117	IN1_OR10	2149	S_SRFF7	2181	STORE3
2118	IN2_OR10	2150	R_SRFF7	2182	STORE4
2119	OUT_OR10	2151	OUT_SRFF7	2183	STORE5
2120	IN1_OR11	2152	NOUT_SRFF7	2184	STORE6
2121	IN2_OR11	2153	CLK_JKFF6	2195	STPRE7
2122	OUT_OR11	2154	OUT_JKFF6	2186	STORE8
2123	IN1_OR12	2155	NOUT_JKFF6	2187	STORE9
2124	IN2_OR12	2156	CLK_JKFF7	2188	STORE10
2125	OUT_O12	2157	OUT_JKFF7	2189	STORE11
2126	IN1_OR13	2158	NOUT_JKFF7	2190	STORE12
2127	IN2_OR13	2159	IN1_ADD4	2191	FREFIN_CRIT0
2128	OUT_O13	2160	IN2_ADD4	2192	FACT_CRIT0
2129	IN1_OR14	2161	OUT_ADD4	2193	FREFOUT_CRIT0
2130	IN2_OR14	2162	IN1_ADD5	2194	DIFFR_CRIT0
2131	OUT_OR14	2163	IN2_ADD5	2195	CONTROL_CRIT0
2132	IN1_4OR1	2164	OUT_ADD5	2196	ACCTIME_CRIT0
2133	IN2_4OR1	2165	IN1_ADD6	2197	CRITICL1_CRIT0
2134	IN3_4OR1	2166	IN2_ADD6	2198	CRITICH1_CRIT0
2135	IN4_4OR1	2167	OUT_ADD6	2199	CRITICL2_CRIT0
2136	OUT_40R1	2168	IN1_ADD7	2200	CRITICH2_CRIT0
2137	S_SRFF4	2169	IN2_ADD7	2201	CRITICL3_CRIT0
2138	R_SRFF4	2170	OUT_ADD7	2202	CRITICH3_CRIT0
2139	OUT_SRFF4	2171	IN_1SHT0	2203	CRITICL4_CRIT0
2140	NOUT_SRFF4	2172	OUT_1SHT0	2204	CRITICH4_CRIT0
2141	S_SRFF5	2173	TIME1_1SHT0	2205	CRITICL5_CRIT0
2142	R_SRFF5	2174	TIME2_1SHT0	2206	CRITICH5_CRIT0
2143	OUT_SRFF5	2175	IN_1SHT1	2207	FIN_OPTIM
2144	NOUT_SRFF5	2176	OUT_1SHT1	2209	FHIGH_OPTIM

Number	Name	Number	Name	Number	Name
2210	IN_PROTECTOR	2215	MAXFREQ_PROTECTOR	2220	MIN0_AOUT0
2211	OUT_PROTECTOR	2216	MAXOM_PROECTOR	2221	MIN1_AOUT1
2212	OVER_1S_PROTECTOR	2217	CHECKTIME_PROTECTOR	2222	MIN2_AOUT2
2213	OVER_PROTECTOR	2218	OVERTIME_PROTECTOR	2223	MIN3_AOUT3
2214	ZEROM_PROTECTOR	2219	CHANGE_PROTECTOR		

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Appendix C – Technical Data

Input Power

Voltage: 460/575 VAC ± 10% **Frequency:** 48 – 63 Hz

Fundamental Power Factor: > 0.98

Line Imbalance: ± 3% of Vin

Output Power

Voltage: 0 – Vin, three-phase (full voltage at field weakening point)

Frequency: 0 – 200 Hz

Frequency Resolution: 0.01 Hz

Frequency Stability: 0.01 % of maximum frequency

Continuous Current : 1.0 x I_{Rated}

Maximum Current (1 min/every 10 min): 1.1 x I_{Rated}

Field Weakening Point: 25 – 200 Hz

Continuous Loadability of Motor: 100% at rated speed (for F class motor)

Analog Inputs

One analog input (A0).

Current Reference: 0 – 20 mA, R_I = 250 ohms

- Minimum: 0 mA / 4 mA / 0 – 20 mA
- Maximum: 0 – 20 mA

Voltage Reference: 0 - 5 V, RI = 200K ohms

- Minimum: 0 V
- Maximum: 5 V

Potentiometer: 2 KOhms ,3 Watt

Potentiometer Reference Voltage: 5 V, 10 mA

Resolution: 10 Bit

Accuracy:

- Analog Control: ± 0.5%
- Digital Control: ± 0.01%

Auxiliary Voltage (for Controls)

24 VDC ± 10%, 200 mA

Digital Inputs

Eight digital inputs.

< 4.0 V is logical 0

> 18 V is logical 1

Digital Outputs

Four digital outputs.

< 4.0 V is logical 0

> 18 V is logical 1

Analog Outputs

Two analog outputs.

Current Output: 0 – 1 mA, R_o = 4K ohms

Voltage Output: 0 - 5 V, 10 mA max

Resolution: 8 Bit

Digital Relay Outputs

Four relay outputs, Form A contacts.

Maximum Switching Voltage: 250 VAC

Maximum Continuous Current: 5 A rms

Environmental Limits

Ambient Operating Temperature: 32× to 104×F (0× to 40×C)

Storage Temperature: - 40×F to + 158×F (-40×C to +70×C)

Relative Humidity: less than 95%, non-condensing

Altitude: 3300 ft (1000 m) above sea level,
derate 1% for every 330 ft (100 m) above 3300 ft (1000 m)

Enclosures

NEMA 1, NEMA 1 Filtered

GLOSSARY

Analog	A system with continuously adjustable values using voltage or current.
Angle, Phase	The difference between two sine waves measured by comparing the two zero crossings.
Asynchronous	Not synchronized or independently varying.
Baud	Rate of transmission of data. Used in serial communication to synchronize the sender to the receiver.
Binary	A numbering system using the base 2, values can be 0 or 1.
Bit	One character of data consisting of 0 or 1.
Buffer	Storage location used for data to be transmitted.
Byte	A character or number consisting of 16 bits in the 1352 Drive.
CBU	Capacitor Bank Unit. A module consisting mainly of capacitors used to filter and provide storage for the DC voltage.
Chopper	A circuit that takes DC and converts it to pulsating DC. Used for controlling the voltage level.
Commutation	Switching the current from one phase to another.
Constant, Time	Time required between repetitive operations used as a measure for an integrator to move one increment.
Control Word	The digital commands for control packed together into one 16 bit number where each bit is analyzed separately.
Converter, A/D	Device that converts an analog signal to a digital number.
Converter, D/A	Device that converts a digital number into a current or voltage level.
CTU	Contactor unit part of a 1352 Drive that provides control of the incoming line and control voltage.
Current, Active	Portion of the current that produces torque.
Current, Reactive	Portion of current that produces motor excitation.
Current, Total	Complete current produced consisting of active and reactive components.
Default	Value provided for a parameter as a part of the program when the drive is started initially.
Differential	That portion of an integrator that is proportional to the rate of change of the input.
Digital	A control system that uses discreet numbers rather than voltage levels.

Diode	A semiconductor that allows current to flow in only one direction.
Diode, Freewheeling	A name given to a semiconductor that provides an alternate path for current to flow when another path is abruptly blocked.
DMS	Drive Maintenance System A computer based program that allows analyzing the 1352 Drive for maintenance purposes.
EE	An abbreviation that indicates a parameter can be stored in EEPROM.
EEPROM	Electrically erasable Programmable Read Only Memory. Memory that can be changed with an electrical signal.
EPROM	Erasable Programmable Read Only Memory. Memory that can only be changed with ultraviolet light; permanent memory.
False	Term that refers to the state of a digital logic signal that is at 0 volts (off).
Fault	Malfunction that is monitored and displayed on the control panel.
Faultword	A group of 16 digital bits each bit indicating a separate fault, packed together as a unit for rapid transmitting.
Firmware	The portion of the program that defines the relationship of the parameters, not normally changed.
Flag	A digital bit that is used as an indicator that a function is active.
Gain	The coefficient of an integrator that determines the multiplier for the input to determine the output.
GTO	Gate Turn Off. Semiconductor that can block current via a low level signal to its gate terminal.
GTR	Giant Transistor. A group of transistors packaged together and operating as one unit.
Hardware	That portion of a drive that is visible and can be touched.
Hexadecimal	Number system using the base 16, used extensively in computers and microprocessors.
Initialization	The act of resetting parameters to their starting value.
Integral	The portion of an integrator that is proportional to the integral of the input and determines the rate of change.
INU	Abbreviation for an inverter unit. converts DC voltage to controlled AC voltage.
Inverter	Portion of a drive that converts DC voltage to AC voltage, sometimes used to refer to the complete drive.
IRE	Abbreviation that refers to the REAL current (active current).
LCU	Line Converter Unit. Unit that converts the AC line voltage to DC bus voltage.

LFU	Line Filter Unit. Portion of a regenerative drive that contains the AC reactor.
LGU	Line Generating Unit. Portion of a Regenerative Drive that converts the regenerative DC voltage to AC.
Location, Memory	A place where a value is stored to be used by the program. Parameter.
Loop, Closed	A type of control that compares a reference signal to a feedback signal, and gives an output proportional to the magnitude and rate of change of their difference.
LRU	Line Rectifier Unit. Combination of a line converter unit and a capacitor bank unit in one module.
LSU	Line Supply Unit. Combination of a line rectifier unit and contactor unit in one module.
Memory	Place where data and instructions are stored for use by the program.
Microprocessor	A silicon chip that can be programmed to process data.
Modulator	A device that is programmed to generate gate pulses to control the voltage and frequency of the drive.
Offset	A constant difference that is set between the input and output of a function block.
Packed Word	A digital number where each bit represents a logical (true or false) signal up to 16 signals can be packed in one word.
Parallel	A type of communications where several signals are sent at the same time. Opposite of serial.
Parameter	A memory address that is used to store data for use by the program.
PLC	Programmable Logic Controller. A microprocessor based device that control the operation of a machine.
Precharge	Supplying a reduced voltage to capacitors to give them an initial charge prior to the full charge to reduce inrush current.
Proportional	Controlling one variable linearly with respect to another variable (constant multiplier).
RAM	Random Access Memory. Memory locations that are most quickly addressed and can be changed readily. Data is lost when power is removed.
Rated	The normal design value for a unit. Nominal value.
Reactor	A coil of wire sometimes wrapped around an iron core to limit the rate of change of current.
Rectifier	A device that converts AC voltage to DC voltage.
Regulator	A device that is used to control the another variable. A controller.

Reset	A signal used to return a function to its zero state.
Ride-Through	The feature where the control is kept operational during short power outages.
ROM	Read Only Memory. Memory locations that can not be changed, the values can only be read.
Scalar	A type of inverter control that controls the motor frequency to determine speed without a tachometer.
Scaling	Changing a variable to a number that is in units that are meaningful.
Serial	A type of communication where data is sent one variable after another. Opposite of parallel.
Software	That portion of the program that can be altered.
Synchronous	Controlling the timing of one device to match another exactly.
Thyristor	A type of drive that can control a large amount of power from a small amount of gate power.
Transducer, Hall Effect	A device that is used to accurately measure AC current at low frequency.
Trends	Storage of various parameters that allows later retrieval and analysis. Often used for fault analysis.
True	A logical expression to indicate that voltage is present.
Uc	An expression for the DC voltage level.
Value, Actual	A feedback signal that is based on measurement rather than calculation. A measured value.
Value, Filtered	A measured value that has had fast transients removed.
Value, Average	A measured value that has been changed to indicate the average over a time interval.
Value, Initial	The value that the program assigns to a parameter upon starting. Default value.
Value, Maximum	The maximum value allowed for a parameter.
Value, Minimum	The minimum value allowed for a parameter.
Value, Reference	The number set into a parameter to indicate to the program the desired output.
Vector	Type of control using a tachometer as feedback to control the motor angle of rotation.

SAMI STAR-US_04A
EFFECTIVE 12/1/94
SUPERCEDES NONE

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