

SIMOREG 6RA70 DC MASTER Electronics

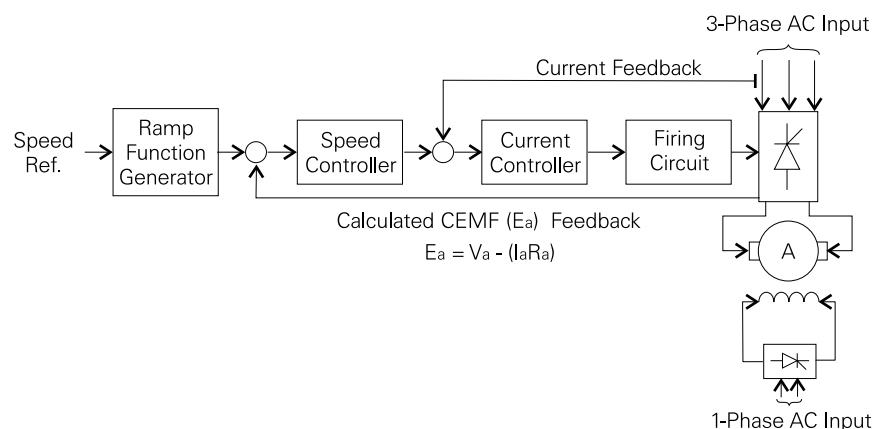
Speed Control with CEMF Feedback

Up to this point we have looked at the power components of a DC Drive necessary to control the speed of a DC motor. The actual control of these components is accomplished with electronic hardware and technology software.

Speed control is one mode of operation. The drive will attempt to maintain a constant speed regardless of the load's torque. A speed reference is input into a ramp function generator which applies reference voltage to the speed controller over a specified period of time. This allows a smoother acceleration of the motor and connected load. The output of the speed controller is routed to the firing circuit, which controls the amount of voltage applied to the armature.

You will recall that V_a (applied voltage) = $I_a R_a$ + CEMF. $I_a R_a$ is proportional to load and is generally 10% of nameplate armature voltage at 100% load. Therefore, as load torque/current varies between 0 and 100%, $I_a R_a$ varies from 0 to 50 VDC for a 500 VDC armature.

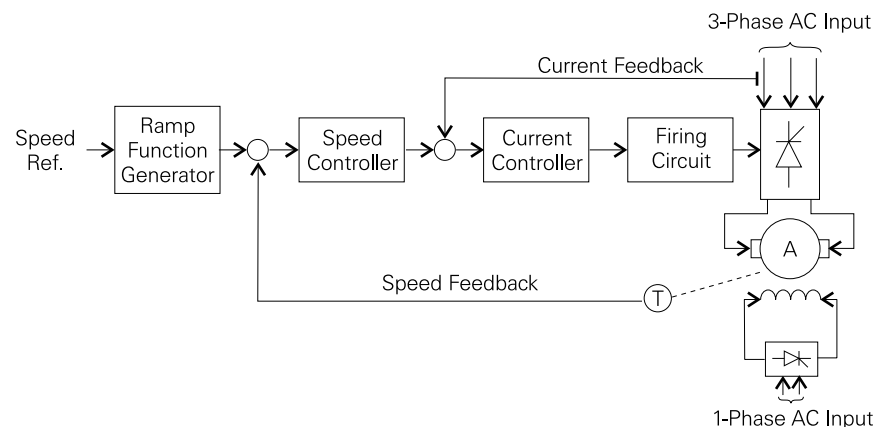
V_a and I_a are constantly monitored. R_a is measured during the commissioning and tuning of the drive. Because V_a , I_a , and R_a are known values, CEMF (E_a) can be precisely calculated. CEMF is proportional to speed and the speed controller uses this value to calculate actual speed. Speed control with CEMF feedback can only be used on applications where the motor operates between zero and base speed. CEMF feedback provides approximately 2-5% speed regulation.



Speed Control with Tach Feedback

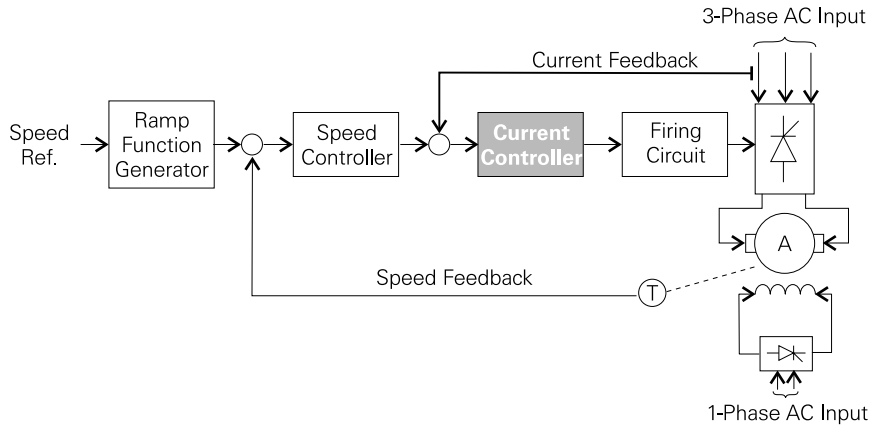
A tachometer can be used when a more accurate measurement of speed is needed, or when the motor will be operated above base speed. A measurement of actual speed is returned to the speed controller. The speed controller will make armature voltage adjustments to maintain constant speed with variations in load. If, for example, load is suddenly increased the motor will slow, reducing speed feedback. The speed controller will output a higher signal to the current controller, which will increase the firing angle of the firing circuit. The resulting increased armature voltage applies more torque to the motor to offset the increased load. Motor speed will increase until it is equal with the speed reference setpoint.

When the motor is rotating faster than desired speed armature voltage is reduced. In a four-quadrant drive DC armature voltage could momentarily be reversed to slow the motor at a faster rate to the desired speed. Several tachs can be used with the SIMOREG 6RA70. DC tachs can provide approximately 0.10 to 2% regulation. Digital (pulse) tachs can provide approximately 0.10 to 0.25% regulation. These values vary depending on the tach and the operating conditions.



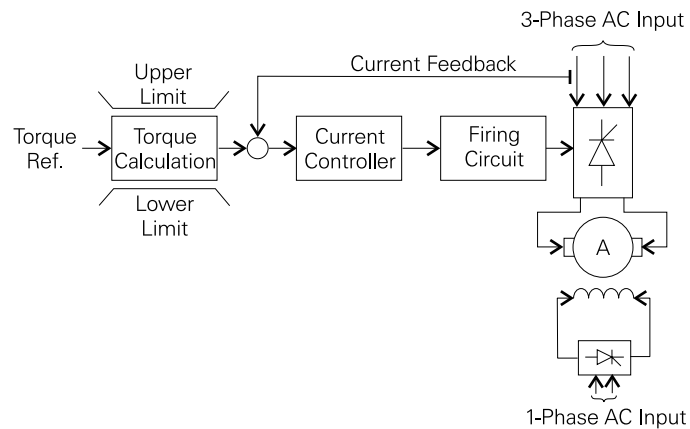
Current Measurement

The drive monitors current, which is summed with the speed control signal at the current controller. The drive acts to maintain current at or below rated current by reducing armature voltage if necessary. This results in a corresponding reduction in speed until the cause of the overcurrent is removed.



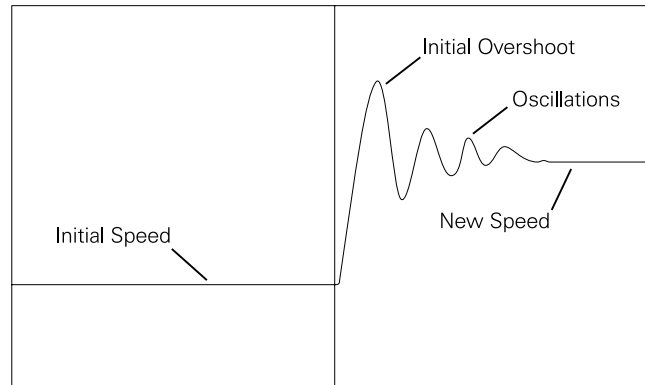
Torque Control

Some applications require the motor to operate with a specific torque regardless of speed. The outer loop (speed feedback) is removed and a torque reference is input. The current controller is effectively a torque controller because torque is directly proportional to current.

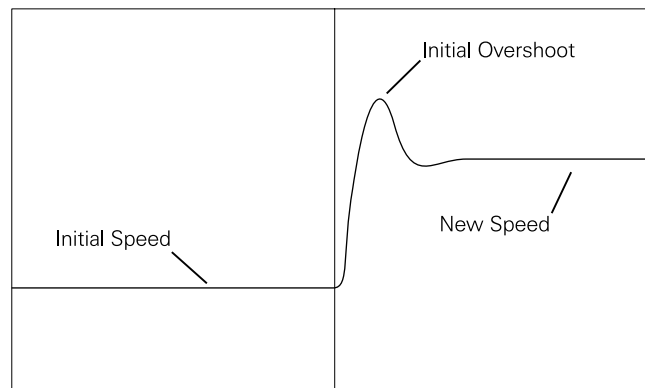


Tuning the Drive

A feature of the SIMOREG 6RA70 DC MASTER is the ability to self tune for a given motor and associated load. An improperly tuned control may result in an excessive speed overshoot when changing from one speed to another. Oscillations can occur which contribute to system instability.



A properly tuned drive will have an initial overshoot of approximately 43% and settle into a new speed quickly. This provides a stable system with quick response.



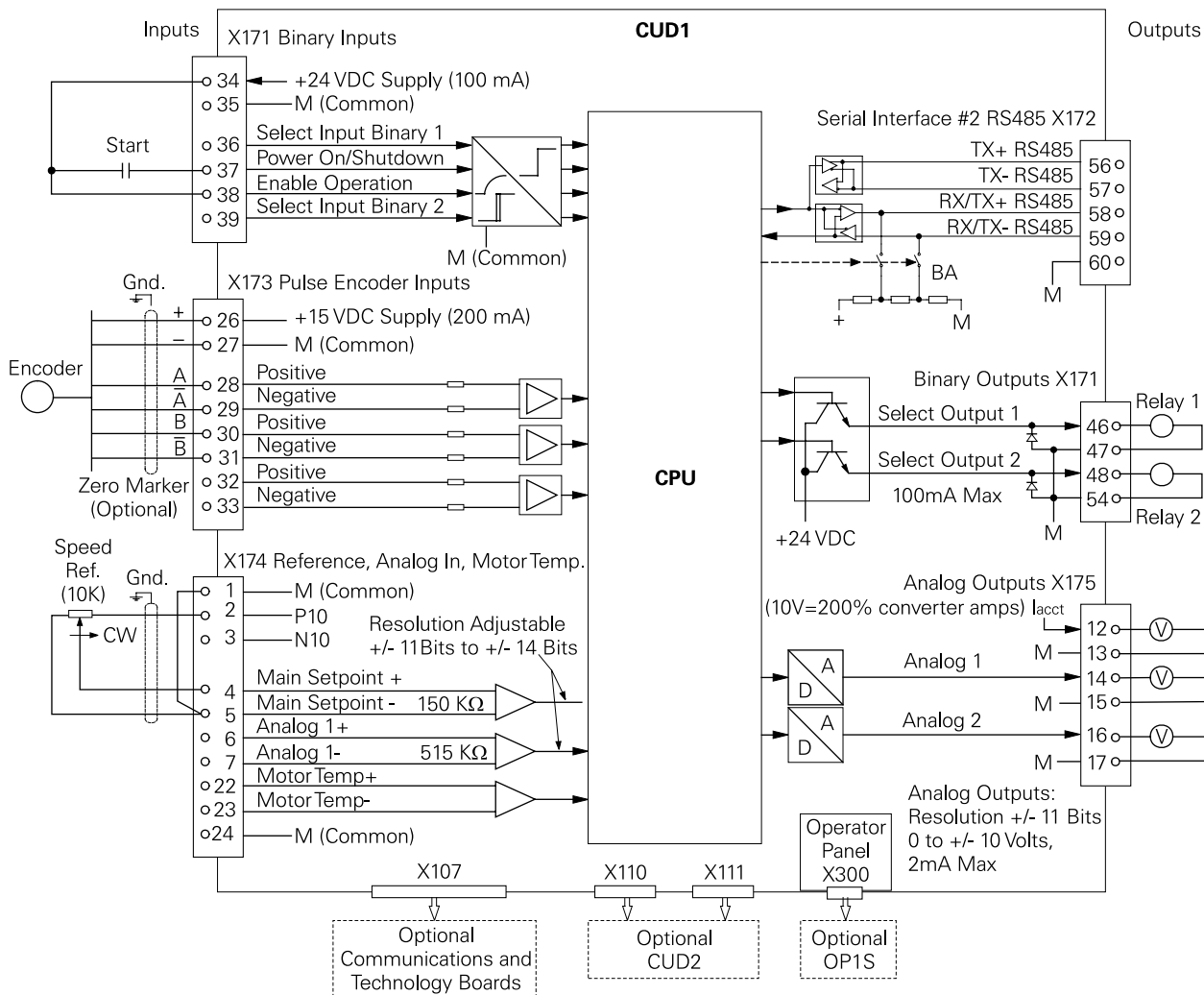
The SIMOREG 6RA70 DC MASTER has three self-tuning routines to match the performance of the drive to the controlled motor and associated load.

- Armature Tuning tunes the drive to the motor characteristics
- Speed Tuning tunes the drive to the connected load
- CEMF Tuning tunes the drive for field weakening

CUD1 Board

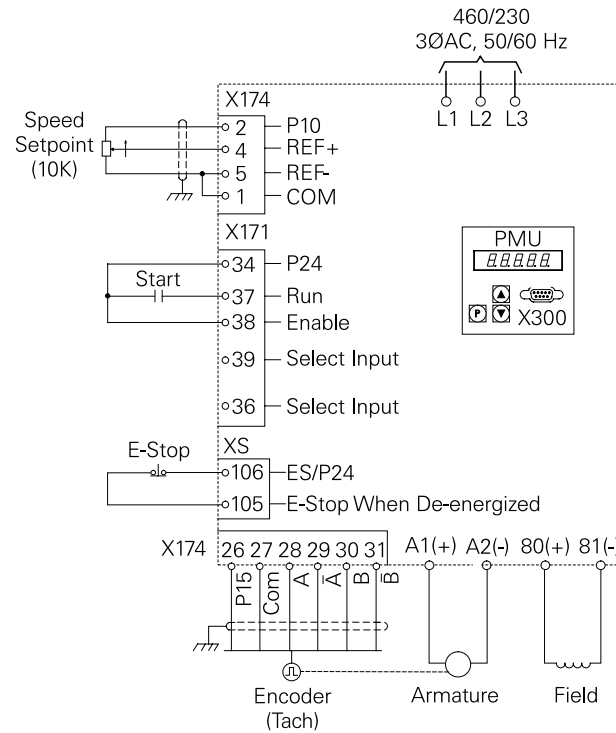
The CUD1 board is the main control board for the SIMOREG 6RA70. This board contains the necessary software and hardware interfaces for operating the drive in speed or torque control. It has input and output connections for wiring the control devices of various functions such as start/stop pushbuttons and speed potentiometer. The CUD1 board has comprehensive diagnostics for troubleshooting. CUD1 also contains the necessary software for self-tuning.

Programmable binary outputs, used to indicate the condition of the drive, are available on X171. Binary inputs are also available to start and stop the drive on X171. In addition, there are two programmable binary inputs for such functions as reverse and jog. The 6RA70 accepts analog inputs for speed control on X174. Programmable analog outputs on X175 provide meter indication of various drive parameters such as current and voltage. A motor temperature switch can be connected to X174 and is used to stop the drive if the motor becomes overheated. Connections are also available on X173 for a digital tach.

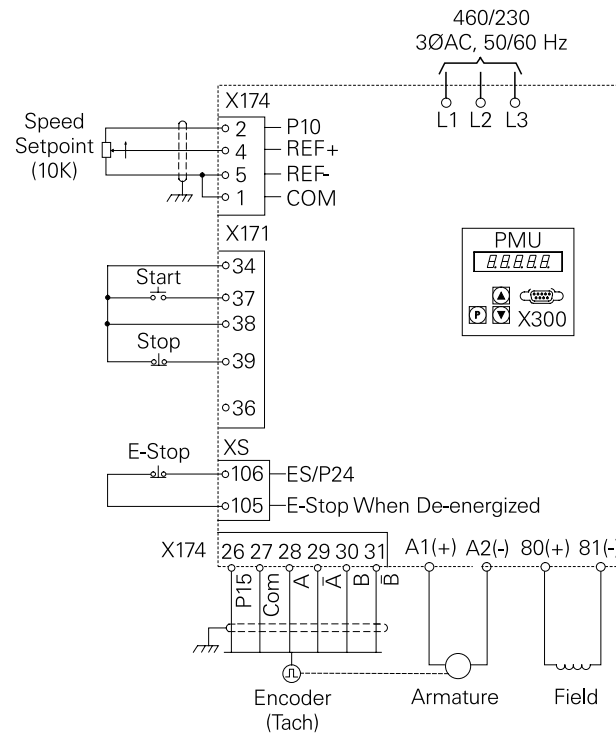


Typical Connections

The following diagram shows a typical connection used to operate the drive. A normally open (NO) contact is used to start and stop the drive.



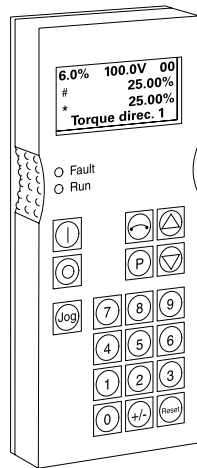
Alternately, pushbuttons can be used to start and stop the drive.



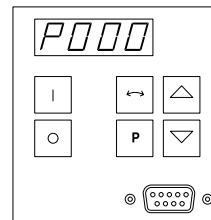
Programming and Operating Sources

SIMOREG 6RA70 drives can be programmed and operated from various sources, such as the PMU, OP1S, or other SIMATIC® HMI device such as the TP170A, TP170B, OP27, or MP370. In addition to these, various methods of serial communication is available through RS232 or RS485 connections. These will be discussed later in this section with the option boards.

The PMU can be used alone or with the OP1S. The OP1S can be mounted directly on the PMU or up to 200 meters away with an external power supply. Parameters, such as ramp times, minimum and maximum speed, and modes of operation are easily set. The changeover key ("P") toggles the display between a parameter number and the value of the parameter. The up and down pushbuttons scroll through parameters and are used to select a parameter value, once the "P" key sets the parameter. The OP1S has a numbered key pad for direct entry. The OP1S has a numbered key pad for direct entry.



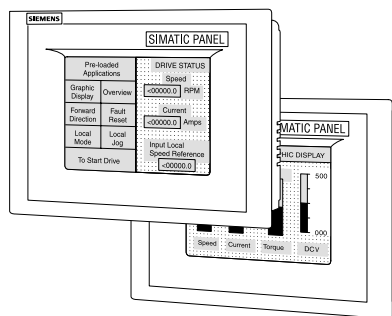
OP1S



PMU

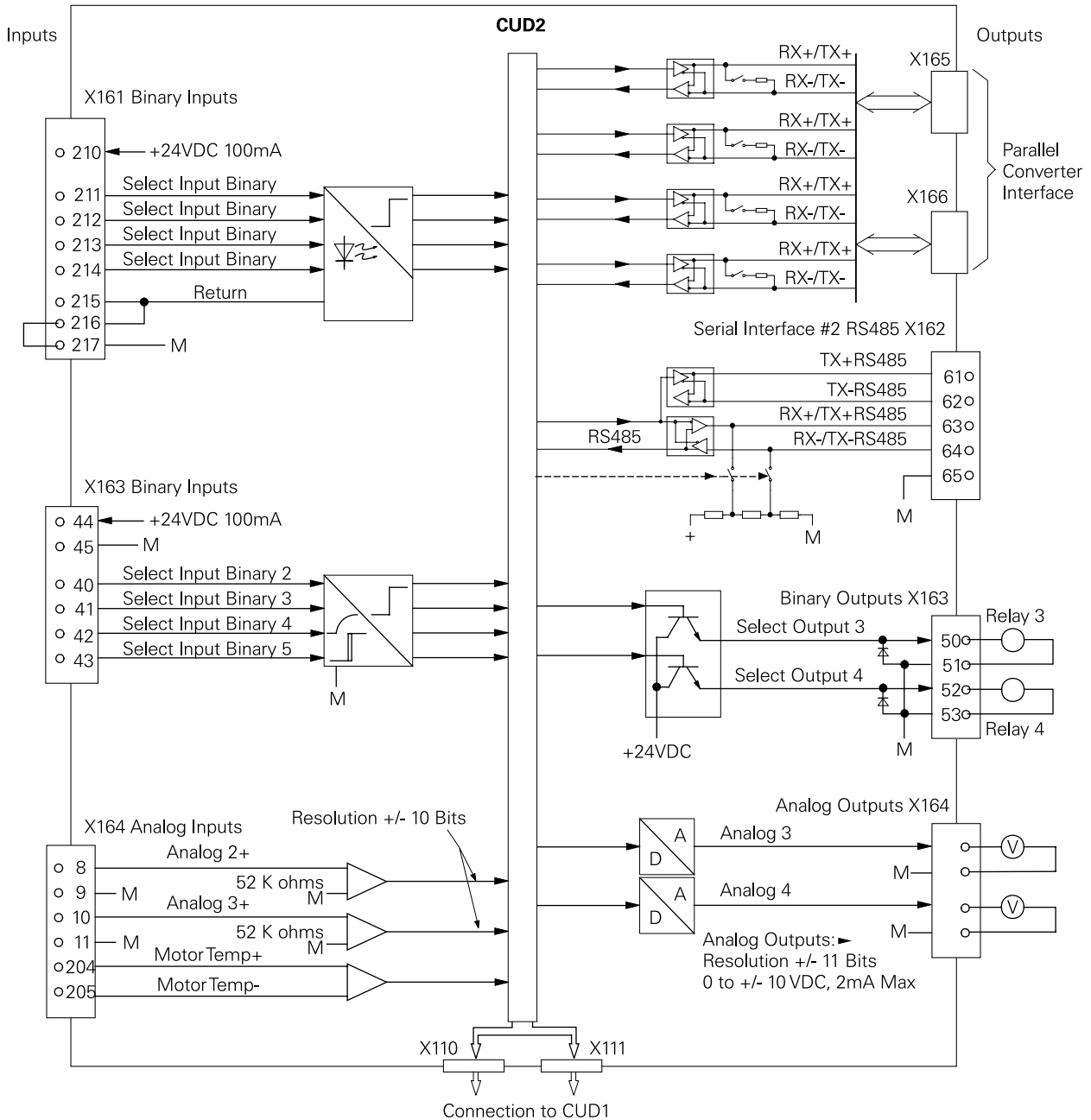
SIMATIC HMI Devices

Another, more robust option, is a SIMATIC HMI device such as the TP170A. The TP170A uses a touch-sensitive screen for control and monitoring. It is powered from the drive and standard PROFIBUS connections.



CUD2 Expansion Board

The CUD2 is typically selected when additional inputs and outputs (I/O) are required. CUD2 I/O is selectable. An advantage to the CUD2 expansion board is that it mounts directly on the CUD1 and requires no additional hardware. The CUD2 provides four optically isolated binary inputs, four selectable binary inputs to ground, two analog inputs, one analog input for motor temperature evaluation, two binary outputs, and one serial interface. In addition to the expanded I/O, the CUD2 provides a parallel interface for paralleling up to six power modules.



EB1 and EB2 Expansion Boards

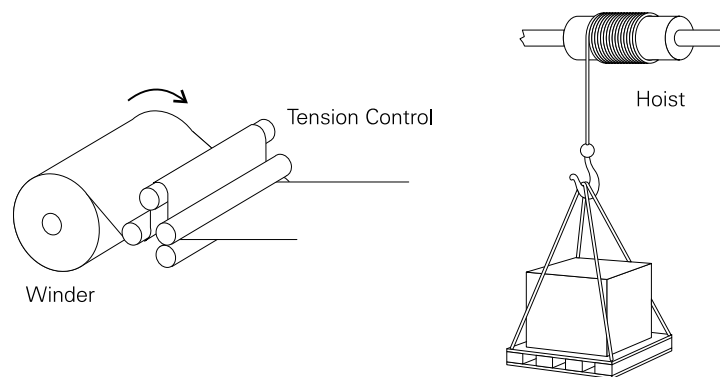
EB1 and EB2 are half-sized expansion boards that provide a number of additional I/O possibilities. EB1 has three binary inputs and four bidirectional binary I/O. Bidirectional I/O can be configured as a binary input or output. One of the analog inputs is used as a voltage or current reference input. Two of the analog inputs can also be configured as binary inputs.

EB2 has two binary inputs, one analog input, one analog output, and four relay contacts. Three of the contacts are normally open (NO) and one of the contacts can be configured as normally open (NO) or normally closed (NC).

I/O	CUD2	EB1	EB2
Isolated Binary Inputs	4	0	0
Binary Inputs	4	3	2
Bidirectional Binary I/O	0	4	0
Analog Inputs	2	3	1
Analog Outputs	2	2	1
Relay (Binary) Outputs	2	0	4
Serial Interface	1	0	0
Parallel Converter Interface	1	0	0

T400 Technology Board

The T400 is an option board that is used to provide specialized features for applications, such as winders, tension control, position control, and hoisting gear. In addition to applying built-in technology functions, users familiar with the Siemens PLC software SIMATIC STEP-7 can also implement their own process functions.



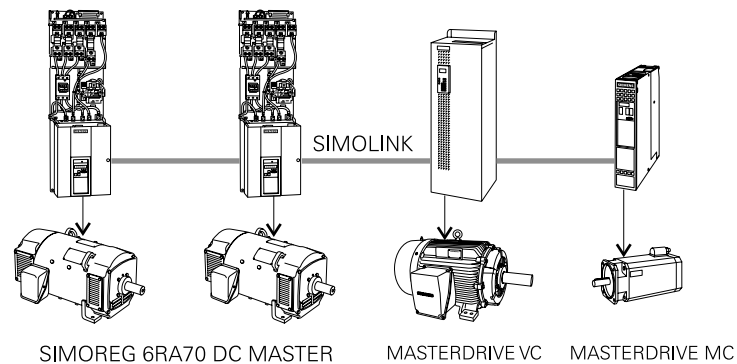
To implement the various control functions required by specific applications the T400 has two analog outputs, five analog inputs, two binary outputs, eight binary inputs, four bidirectional binary inputs/outputs, two incremental encoder inputs, and two serial interfaces.

Communications

One of the strong points of the SIMOREG 6RA70 is its serial interface capabilities, which makes it easy to integrate the drive with other automation components. Communication options are available for PROFIBUS-DP, SIMOLINK®, CAN, and DeviceNet communications.

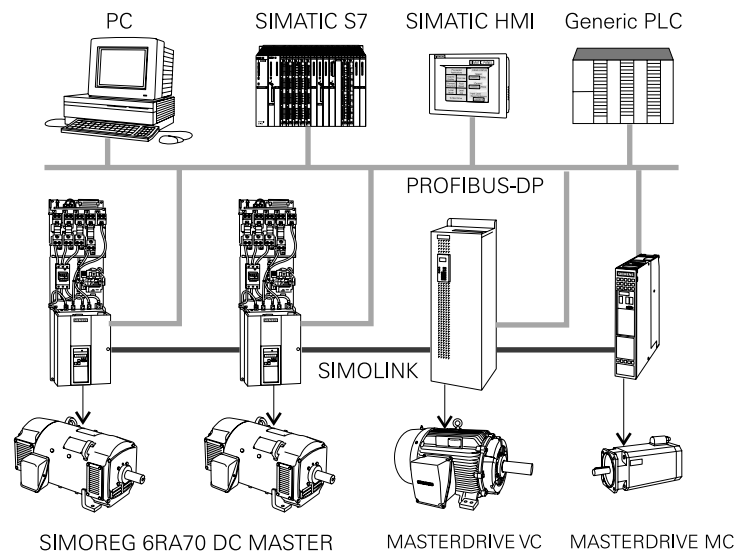
SLB

The SLB communication board is used for peer-to-peer communication with other Siemens drives via SIMOLINK. SIMOLINK is a high speed fiber optic ring bus that allows various data to be passed from one drive to the next. Communication is not limited to the SIMOREG 6RA70. SIMOLINK can also communicate between Siemens AC drives such as the MASTERDRIVE MC and MASTERDRIVE VC.



CBP2

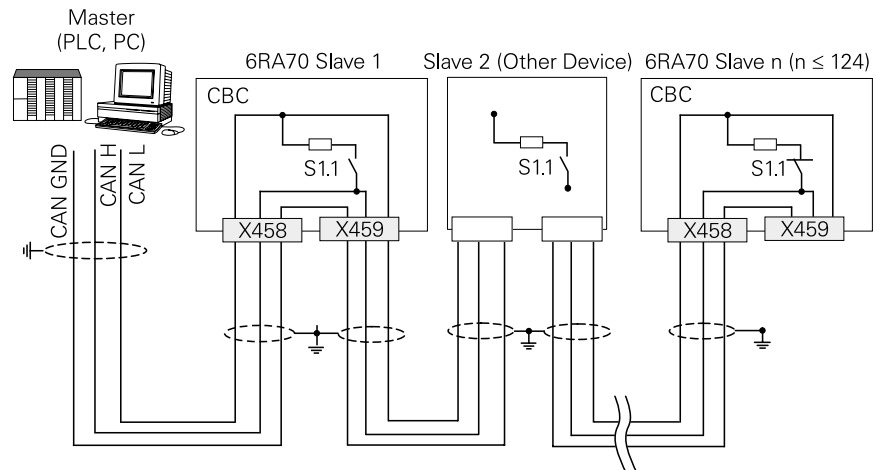
PROFIBUS-DP is an open bus standard for a wide range of applications in various manufacturing and automation applications. Siemens DC drives can easily communicate with other control devices such as programmable logic controllers (PLCs) and personal computers (PCs) through the PROFIBUS-DP communication system and other various protocols. The CBP2 board is required to communicate via PROFIBUS-DP.



CBC

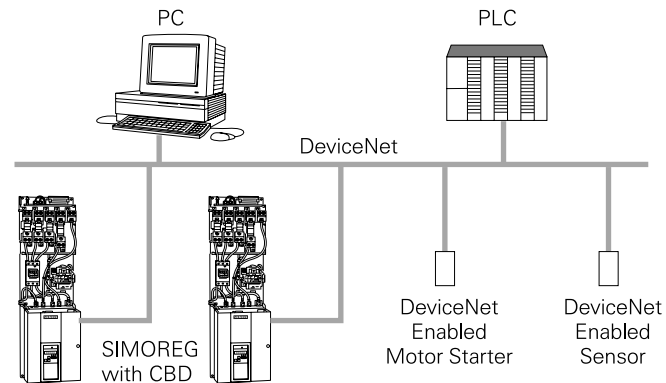
ISO is a federation of standards organizations from over 100 countries that develops voluntary standards for business, science, and technology. The official name is Organization Internationale de Normalisation, also known in the United States as the International Organization for Standardization.

The CBC communication board is used to communicate with CAN protocol, which is an ISO standard (ISO 11898) for serial data communications. CAN protocol was initially developed in 1986 for the automotive industry. Today communication with CAN protocol can also be found in other industrial automation applications. One device, such as a PLC or computer, acts as a master. SIMOREG drives equipped with CBC boards and other controllable devices configured for CAN act as slaves. CAN uses a simple twisted pair of wires for transmission of control and parameter value data between SIMOREG drives with CBC boards.



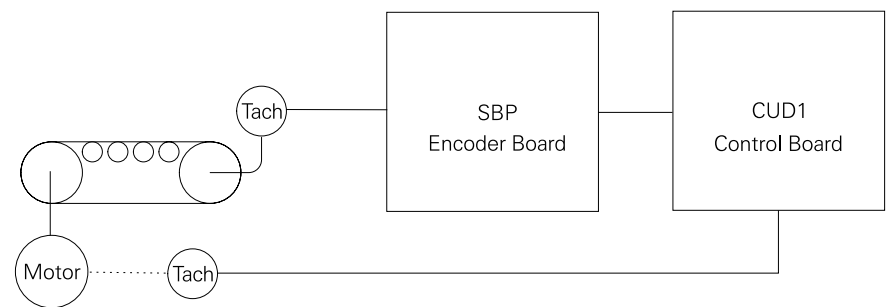
CBD

The CBD communication board is used to communicate with DeviceNet. DeviceNet is another communication protocol that was developed based on the CAN technology. DeviceNet provides a low-level network for DeviceNet enabled devices such as sensors, motor starters, and drives to communicate with higher-level devices such as computers and PLCs. DeviceNet can read the state of devices, such as on/off, as well as start and stop motors (motor starters). SIMOREG 6RA70 DC MASTERS equipped with a CBD board can be added to a DeviceNet network. A DeviceNet enabled master device can control the operation, such as start, stop, accel, and decel.



SBP

Digital tachometers (encoders) can be used to measure the actual speed of a motor. The SBP encoder board can be also be used to monitor an external encoder, such as might be connected to the driven machine.

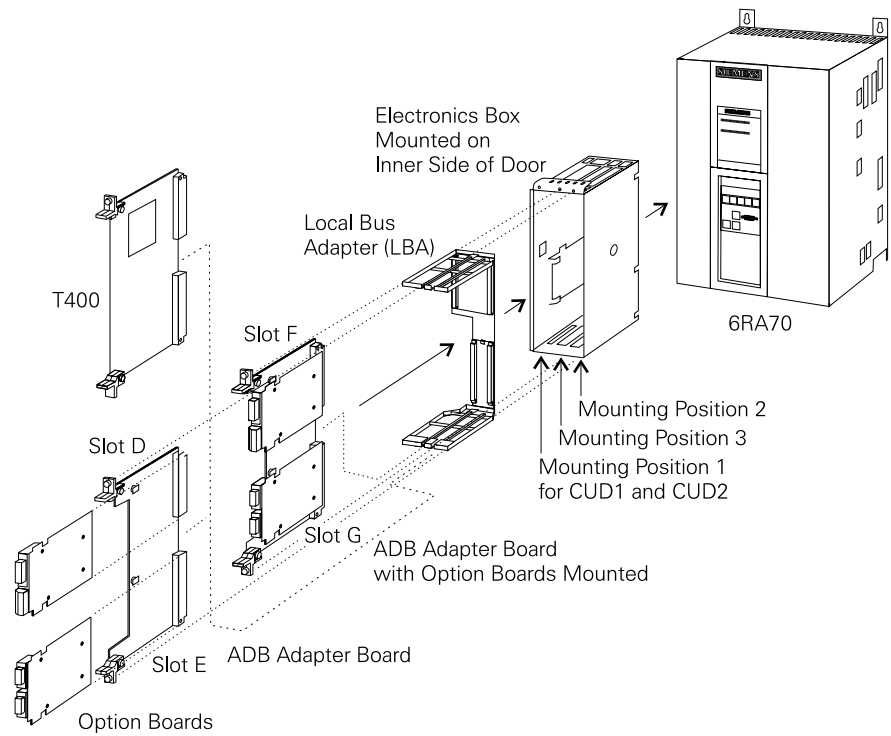


Electronics Box

The electronics box contains the CUD1 board (main control board) and option boards. The CUD1 board is plugged into slot 1.

Mounting Option Boards

There are several option boards available, which will be discussed later in this section. Option boards are automatically recognized by the drive. Up to six boards can be installed in the electronics box. A Local Bus Adapter (LBA) is required if mounting positions 2 or 3 are needed. In addition, adapter boards (ADB) are necessary for slots D, E, F, and G when utilizing the half-size option boards.



There are a few rules that must be followed when mounting option boards:

- Option boards may be plugged into positions 2 or 3, however, position 2 must be filled first.
- When used, a technology board (T400) is always installed in position 2.
- If a communication board (CBP2, CBC. or CBD) is used with a technology board the communication board is placed in slot G.
- It is unnecessary and not possible to use expansion boards EB1 and EB2 in conjunction with the technology board T400. T400 has its own expanded inputs and outputs (I/O).
- It is unnecessary and not possible to use the pulse encoder board (SBP) or the SIMOLINK communication board (SLB) in conjunction with T400. T400 has provision to connect an encoder.
- A maximum of two supplementary boards of the same type may be used in one drive. For example, no more than two communication boards or two expansion boards can be used.

The following chart shows the mounting positions for CUD1 and option boards.

Board	LBA	ADB	Location 1	Location 2		Location 3	
				D	E	F	G
CUD1	No	No	Yes	No	No	No	No
CUD2	No	No	Yes	No	No	No	No
CBP2	Yes	Yes	No	Yes	Yes	Yes	Yes
CBC	Yes	Yes	No	Yes	Yes	Yes	Yes
CBD	Yes	Yes	No	Yes	Yes	Yes	Yes
SLB	Yes	Yes	No	Yes	Yes	Yes	Yes
SBP	Yes	Yes	No	Yes	Yes	Yes	Yes
T400	Yes	No	No	Yes		No	
EB1	Yes	Yes	No	Yes	Yes	Yes	Yes
EB2	Yes	Yes	No	Yes	Yes	Yes	Yes

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1. _____ is the designation of the main electronic control board in the SIMOREG 6RA70 DC MASTER.
2. A _____ _____ _____ is required when mounting option boards in the electronics box.
3. Position _____ must be filled first when installing option boards.
4. _____ tuning tunes a drive to the motor characteristics.
5. Technology board T400 can be installed in location _____ .
6. An advantage of the CUD2 expansion board is that it mounts directly on _____ and requires no additional hardware.
7. _____ expansion board has the most bidirectional binary I/O.
 - a. CUD2
 - b. EB1
 - c. EB2
8. _____ is used to communicate with PROFIBUS-DP.
9. _____ is used to communicate with other Siemens drives via SIMOLINK.
10. A second digital tachometer is connected to the drive through an _____ board when T400 is not used.