Chapter 1	*Introduction*

This chapter describes:

- The High Speed Counter Module
- Basic module features
- The module's inputs and outputs
- Configurable counter types

High Speed Counter Module

The High Speed Counter module, catalog number IC693APU300, for the Series 90™-30 Programmable Logic Controller (PLC) provides direct processing of rapid pulse signals up to 80 kHz for industrial control applications such as:

- Turbine flowmeter
- Meter proving
- Velocity measurement
- Material handling
- Motion control
- Process control

Direct processing means that the module is able to sense inputs, process the input count information, and control the outputs without needing to communicate with a CPU.

The High Speed Counter uses 16 words of input memory. This consists of 16 bits of discrete input memory (%I) and 15 words of analog input memory (%AI). These inputs are updated once per CPU sweep. The High Speed Counter also uses 16 bits of discrete output memory (%Q) which are transferred once per sweep.

The High Speed Counter is configured using the Series 90™-30 Hand-Held Programmer or the Logicmaster™ 90-30 Programming Software Configurator function. Many features can be configured from the user's application program as well. Each feature is set to a factory default configuration which is suitable for many applications. There are no jumpers or DIP switches to set on the module. Two green LEDs at the top of the module indicate the operating status of the module and the status of configuration parameters.

Configurable Counter Types

When the module is configured, a counter type must first be selected. The choices are:

- Type A - selects 4 identical, independent simple counters
- Type B - selects 2 identical, independent more complex counters
- Type C - selects 1 complex counter

Type A Configuration

When used in this basic configuration, the module has four identical programmable up or down 16-bit counters. Each counter can be programmed to count either up or down. Each has three inputs: a Preload input, a Count Pulse input, and a Strobe input. In addition, each counter has one output, with programmable on and off Output Presets.

Type B Configuration

In its Type B configuration, the module has two identical bidirectional 32-bit counters. The count inputs may be configured to accept Up/Down, Pulse/Direction, or A Quad B signals. For a Type B counter configuration, each counter has two completely independent sets of Strobe inputs and Strobe registers. Each counter also has two outputs, with each output having programmable on/off Presets. A Disable input can be used to suspend counting.

Type C Configuration

In the Type C configuration, the module has one 32-bit counter with four outputs, each with programmable on/off output presets, three strobe registers with strobe inputs, and two Preload values with Preload inputs. In addition, the module has a Home Position register for preloading the Accumulator to the Home Position value. Two sets of bidirectional counter inputs can be connected to operate in a differential fashion. Each set of inputs can be configured for A Quad B, Up/Down, or Pulse/Direction operation. The Type C configuration is suitable for applications requiring motion control, differential counting, or homing capability.

Description of Module

Additional module features include:

- 12 positive logic (source) inputs with input voltage range selection of either 5 VDC or 10 to 30 VDC
- 4 positive logic (source) outputs
- Counts per timebase register for each counter
- Software configuration
- Internal module diagnostics
- Individual LEDs that provide a visual indication of Module OK and Configured OK status
- A removable terminal board for connection of field wiring

Inputs can be used as count signals, direction, disable, edge-sensitive strobe, and preload inputs depending on the counter type selected by the user. Outputs can be used to drive indicating lights, solenoids, relays, and other devices.

Power to operate the module's logic circuitry is obtained from the baseplate backplane's 5 VDC bus. Power sources for input and output devices must be supplied by the user or by the +24 VDC Isolated output of the Model 30 power supply. The module also provides a selectable threshold voltage to allow the inputs to respond to either 5 VDC signal levels or 10 to 30 VDC signal levels. The 5 VDC threshold is selected by connecting a jumper between two terminals on the detachable terminal board connector. Leaving the threshold selection terminals unconnected places the inputs in the default 10 to 30 VDC voltage range. The detachable terminal board connector allows prewiring to the module or replacing the module without disturbing the field wiring. It is important to note that **10 to 30 VDC must not be applied when the threshold terminals are jumpered to select 5 VDC.**
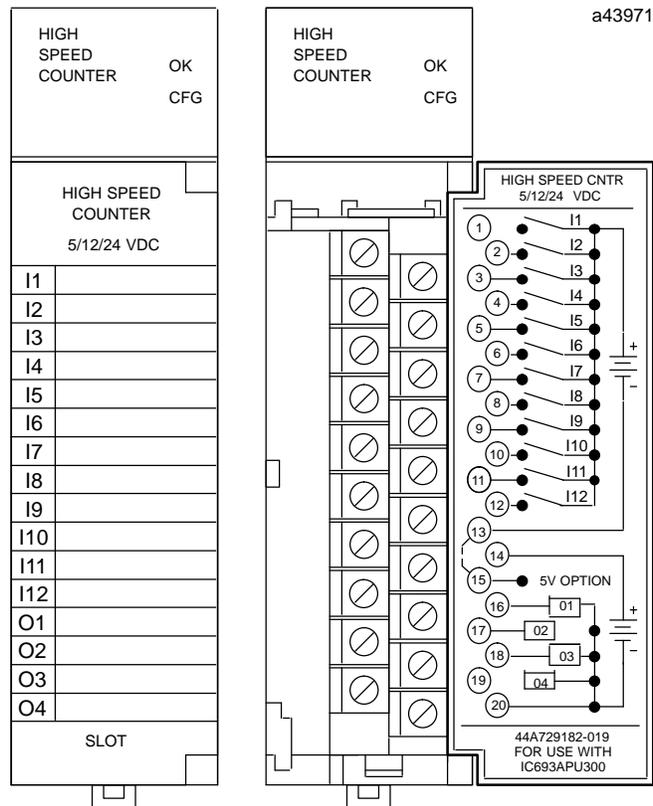

Figure 1-1. Series 90-30 High Speed Counter Module

For each counter, a Counts per Timebase register indicates the number of counts in a given time interval. The Counts per Timebase data is a 16-bit signed number. The sign indicates up counts (+) or down counts (–). The Timebase value is specified in milliseconds and ranges from 1 to 65535 milliseconds.

All configuration parameters for the module are downloaded from the PLC to the High Speed Counter after it passes its internal diagnostics and the MODULE OK indicator has turned on. An initial (default) set of configuration parameters is loaded during diagnostics. These default parameters may be used "as is" or modified through a download from the PLC, or the parameters may be changed by the user with the Hand-Held Programmer. When the user configuration is complete, the CONFIG OK LED will turn on.

Operation of the High Speed Counter module is monitored by a watchdog timer circuit which, if it detects a module failure, will force all outputs off and turn off the MODULE OK LED.

Basic Features

Oscillator:

The module also provides an internal square wave oscillator output that can be configured as a count input for the **first counter only** and used as a timing reference for measurement. The output is set for a default frequency of 1 kHz. A higher or lower frequency can be selected using the Hand-Held Programmer, or by the application program.

Direct Processing:

The module is able to sense inputs, count and respond with outputs without the need to communicate with a CPU.

Selectable number of counters per module:

The module provides 1, 2, or 4 counters of various complexity.

Selectable counter operation:

Counters can be configured to count either up or down, count both up and down, or count the difference between two changing values (*depending on counter type selected*).

Continuous or single-shot counting:

Each counter can be configured to operate in either continuous or single-shot mode:

Continuous Counter Mode: If either the upper or lower count limit is exceeded, the counter wraps around to the other limit and continues.

Single-Shot Counter Mode: The counter counts to either limit and stops. When the counter is at the limit, counts in the opposite direction back it off the limit. The Accumulator can also be changed by loading a new value from the CPU or by applying a Preset Input.

Accumulator for each counter:

Each counter's accumulated count is stored separately. The CPU can read the value in the accumulator, or set it from the application program. The accumulator value can be either positive or negative. When negative, the value is two's complement.

Accumulator adjust:

For each counter, the Accumulator may be adjusted. The adjustment is an 8-bit signed offset value that is sent from the CPU whenever an adjustment is required.

Selectable Input Filters:

The Count and Control inputs for each counter can be configured for a high-frequency filter (2.5mS) or a low-frequency filter (12.5mS).

Count Rate:

Maximum count rates are 80 kHz with the high-frequency filter and 30 Hz with the low-frequency filter.

Selectable On/Off Output Presets:

Each counter output has two Preset points, ON and OFF. The output state indicates when the counter accumulator value lies between the defined points. For example:
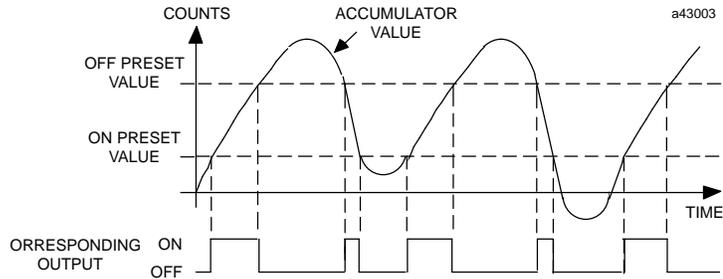
The output polarity may be configured to be either on or off between points by the relative location of the ON/OFF presets as shown below.

Preset closest to low limit	Output ON	Output OFF
ON	> = ON Preset	> OFF Preset
	< = OFF Preset	< ON Preset
OFF	< OFF Preset	< = ON Preset
	> ON Preset	> = OFF Preset

ON CONDITION INCLUDES PRESET POINTS

OFF CONDITION INCLUDES PRESET POINTS
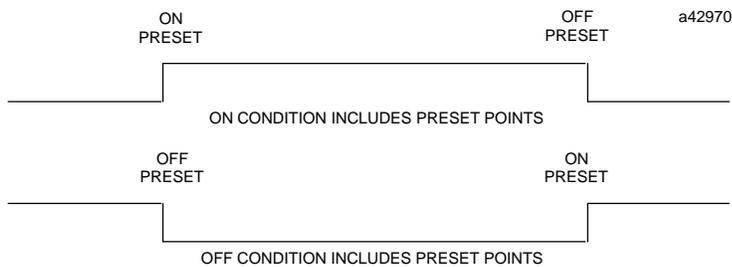
Counts per Timebase can be used to measure the rate of counting:

Each counter stores the number of counts that have occurred in a specified period of time. A timebase value from 1 millisecond to 65535 milliseconds is configurable. The Counts per Timebase register value returned in the %AI will update at the timebase interval. Counts per Timebase values will be retrieved by the PLC I/O update during the normal PLC sweep.

Strobe Register:

Each counter has one or more strobe registers that capture the current Accumulator value when a Strobe input transitions in the direction selected during the last

configuration of the module. It is recommended that the rising edge of the strobe input be used for best performance.

Module Inputs and Outputs

The High-Speed Counter Module accepts 12 input signals, and can provide 4 output signals.
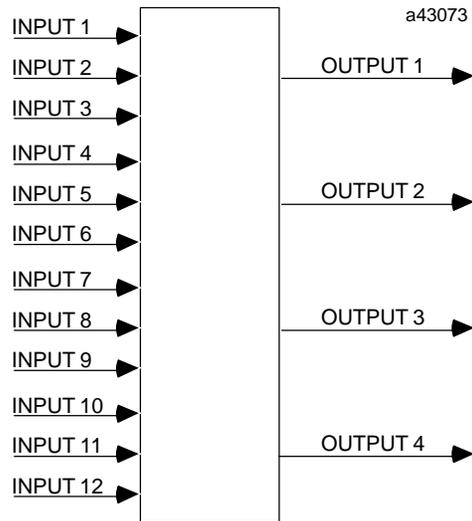
Inputs

Inputs include count signals, Direction, Disable, edge-sensitive Strobe, and other inputs which can be configured for the application. Input filters can be configured for high frequency or low frequency operation.

Count Inputs:

A rising edge on a count input will increment or decrement its Count Accumulator. The method of counting depends upon the counter type and the count mode configuration.

The Count input is positive-edge sensitive. It may be configured to have either the high-frequency (2.5mS) or low-frequency filter (12.5mS). The default filter is high-frequency.

Preload Inputs:

Each counter has a configurable preload register. The contents of this register determine the value the counter resets to when the Preload input goes active. The default value of the Preload register is zero.

The Preload input is positive-edge sensitive. It may be configured to have either the high-frequency (2.5mS) or low-frequency filter (12.5mS). The default is high-frequency.

If Preload occurs during counting, preload data with a resolution of Ç 1 count is stored in the accumulator and a Preload flag is set to indicate to the CPU that a Preload occurred.

Strobe Inputs:

Strobe inputs are edge-sensitive. They may be configured to respond to either the positive or negative edge. Strobe inputs always have the 2.5nS high-frequency filter enabled. On counter types with multiple strobe inputs, the strobes may occur simultaneously without affecting the integrity of the data strobed. When the strobe signal goes active, count data with a resolution of one count is stored in the associated Strobe register and a Strobe flag is set to indicate to the CPU that a strobe value was captured. ***This value remains in the Strobe register until the Strobe signal goes active again, at which time it is overwritten.*** Each time the CPU acknowledges receipt of the Strobe flag, the application program should clear it.

If a Strobe input and Preload input both go active in the same 0.5mS interval, both the Accumulator and Strobe register will be set to the Preload value.

Other Inputs:

These are described under the discussion of operation for each counter type.

Outputs

The module's four outputs can be used to drive indicating lights, solenoids, relays, and other devices. The outputs are also capable of driving CMOS level loads. Each output is a positive logic (source) output, with power supplied from a user supplied power source. The outputs are protected against short circuits by a common 3 Amp pico fuse. Diodes protect outputs against transients going below output common. Each output can source a maximum of 500 mA at 10 to 30 VDC or 20 mA at 5 VDC.

The module's outputs can be programmed to turn on or off when the accumulated count reaches appropriate values. The count input-to-output delay is 1mS maximum (200nS minimum) plus the configured Input Filter Time.

Configuring the High Speed Counter

There are two schemes that may be followed for configuration of the High Speed Counter:

- When the High Speed Counter module is installed in its selected slot in a Series 90-30 PLC baseplate, the Hand-Held Programmer may be used for on-line configuration.

- Off-Line configuration can be accomplished using the Logicmaster 90 configurator software.

Configuration for Installed Module

When the High Speed Counter module is installed, configuration data entered by the user, in response to the Hand-Held Programmer screens, is stored in the configuration memory area of the PLC. When the configuration is complete, the PLC sends this configuration data to the High Speed Counter.

Screens for Configuration

The screens for configuring the %I, %AI, and %Q references are explained in detail in the Series 90-30 Hand-Held Programmer User's Manual, GFK-0402. *If the value input by*

the user is not an acceptable value for that configuration parameter, the High Speed Counter will respond with an error message. Error messages are also described in the Hand-Held Programmer User's Manual.

Module Specifications

General:	
Operating Temperature	0°C to 60°C (32° F to 140° F)
Storage Temperature	−40 °C to +85°C (−40° F to 185° F)
Humidity	5% to 95% (non-condensing)
Module Operating Voltage	5 VDC (from backplane)
Module Power Dissipation	1.25 watts (250 mA)
Maximum Count Rate	200 kHz
Output Points	Powered by user supplied 5V, or 10 to 30 VDC
LEDs	BOARD OK and CONFIG OK
Isolation	1500 volts between field inputs and logic side 1500 volts between field outputs and logic side 1500 volts between field inputs and field outputs
Number of Modules per System	
Model 311/313,5-slot	4
Model 311/313,10-slot	4
Model 331/340/341/351	8
Inputs	
Voltage Range	5 VDC (TSEL jumpered to INCOM)
	10 to 30 VDC (TSEL open)
Number of Positive Logic Outputs	12
Input Thresholds (I1 to I12)	*5 VDC Range* *10 to 30 VDC Range*
V_{on}	3.25 V Range 8.0 V minimum
I_{on}	3.2 mA minimum 3.2 mA minimum
V_{off}	1.5 V maximum 2.4 V maximum
I_{off}	0.8 mA maximum 0.8 mA maximum
Survivable Peak Voltage	± 500 V for 1μSec
Transient Common Mode Noise Rejection	1000V/μSec minimum
Input Impedance	See Figure 1-2 for V-I characteristics
Outputs	
Voltage Range	10 to 30 VDC @ 500 mA maximum
Voltage Range	4.75 to 6 VDC @ 20 mA maximum
Off State Leakage Current	10 μA maximum per point
Output Voltage Drop at 500 mA	0.5 V maximum
CMOS Load Drive Capability	Yes
Positive Logic Outputs	4
Output protection	Outputs are short circuit protected by a 3A pico fuse common to all 4 outputs