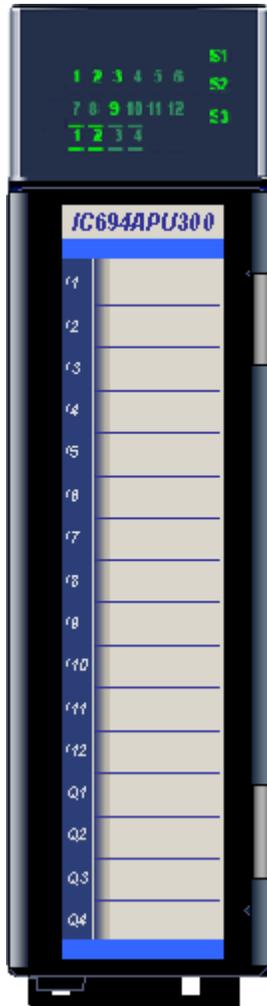


PACSystems* RX3i

IC694APU300-EC

High-speed Counter Module

GFK-2796D
December 2015



The PACSystems* High-speed Counter module, IC694APU300, provides direct processing of rapid pulse signals up to 1 MHz. The module senses inputs, processes the input count information, and instantaneously controls the outputs per each counter's configuration without needing to communicate with a central processing unit (CPU). The module can be configured to have:

- 4 identical, independent simple counters
- 2 identical, independent more complex counters
- 1 complex counter

Module Features

- 12 positive logic (source) inputs with input voltage range selection of either 5 V dc or 10 to 30 V dc
- 4 positive logic (source) outputs
- Counts per timebase register for each counter
- Internal module diagnostics
- Removable terminal board for field wiring

The IC694APU300 module provides two modes of operation when used in an RX3i system: *Classic* and *Enhanced*.

Enhanced Mode Features

The APU300 operates in Classic mode by default. To use the additional features provided in Enhanced mode, select Enhanced mode using the Proficiency Machine Edition configuration tool. Enhanced mode features include:

- Support for up to 1 MHz input frequency from external devices and up to 2 MHz internal oscillator at clock input 1
- Additional Input filtering options: 5 ms, 500 μ s, 10 μ s and no filter
- Support for both Single Ended and Differential Encoders
- Support for 32-bit counters
- Support for Z input events
- Windowing feature that enables user to define a range of counter accumulator values wherein the strobe is recognized as valid input. If the counter accumulator value lies outside this range, the strobe input is ignored.
- ESCP outputs with 1.5 A per point minimum
- Configurable outputs
- Roll over detection flag
- Support for COMMREQ functions and module control data commands
- Module reports its part number, serial number and revision to the CPU
- Support for firmware updates over the backplane from the RX3i CPU

GFK-2796D

Module Power

Power for the module is drawn from the backplane's 5 V dc bus. Power sources for input and output devices must be supplied by the user or by the +24 V dc Isolated output of the power supply.

The blue bands on the label indicate that the APU300 is a low-voltage module that can be installed in any I/O slot in a Series 90-30 or RX3i system.

The APU300 can be replaced and removed only in an RX3i system without shutting down the system, following the instructions in the *PACSystems RX3i System Manual (GFK-2314E)* or later. When the module is removed from the backplane or power-cycled, it stops counting and accumulated counts are lost.

Specifications

General	
Power Consumption	250 mA (1.25 watts) from 5 V bus on the backplane
Output Points	Powered by user supplied 4.7 to 40 V dc
Maximum Count Rate	1 MHz, (Duty Cycle 25% to 87%)
LEDs	BOARD OK, CONFIG OK, Field Power OK, Input Status, Output Status
Isolation:	
Field to Backplane (optical) and to Frame Ground (FG)	250 V ac continuous, 1500 V ac for one minute
Group to Group	250 V ac continuous, 1500 V ac for one minute
Inputs	
Voltage Range	5 V dc (TSEL jumpered to INCOM) 10 to 30 V dc (TSEL open)
Number of Positive Logic Inputs	12 (Single Ended) or 6 (Differential)
Input Thresholds (I1 to I12)	5 V dc Range 10 – 30 V dc Range
Von (minimum)	3.55 V 8.35 V
Ion (minimum)	3.2 mA 3.2 mA
Voff (maximum)	1.5 V 2.4 V
Ioff (maximum)	0.8 mA 0.8 mA
Survivable Peak Voltage	± 500 V for 1µSec
Transient Common Mode Noise Rejection	1000 V/ µSec minimum
Input Impedance	Refer to the section <i>Input Impedance</i> for V-I characteristics.
Outputs	
Voltage Range	4.7 to 40 V dc at 1.5A maximum resistive load, 0.5A maximum pilot duty
Off State Leakage Current	10 µA maximum per point
Output Voltage Drop	0.5 V maximum at 500 mA 1.5 V maximum at 1.5 A†
Inrush Current	1.6A without ESCP tripping
CMOS Load Drive Capability	Yes
Positive Logic Outputs	Four
Output Protection	Outputs are protected for overcurrent (ESCP) with self-healing capability
Reverse Polarity Protection	Outputs protected from reverse wiring between OUTPWR and OUTCOM terminals

† **Note:** The output voltage drop should be considered while driving full load (> 1 A) at low voltage below 6 V.

For product standards, general operating specifications and installation requirements, refer to the following documents:

- *Series 90-30 PLC Installation and Hardware Manual (GFK-0356)*

- *Installation Requirements for Conformance to Standards (GFK-1179)*

For detailed information on module installation, configuration, operation, and diagnostics, refer to the *PACSystems RX3i and Series 90-30 High-speed Counter Modules User Manual (GFK-0293)*.

Manuals and other user documentation are available for download on the Support website: <http://ge-ip.com/support>.

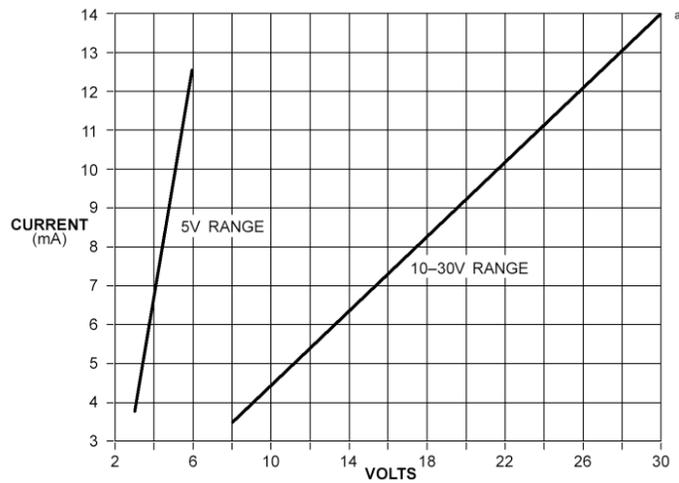
I/O Performance for Enhanced Versions (-MA / -CA and Later)

Parameter	Timing Specification
Input Points	
Turn On Delay	Input filter time + 150 nSec
Turn Off Delay	
Output Points	
Turn On Delay †	0.5 mSec maximum
Turn Off Delay †	0.5 mSec maximum
Maximum time between HSC output point updates	0.5 mSec
† Switch circuit delay only.	

Total Input-to-Output delay = Input filter time + 125 μSec minimum

Total Input-to-Output delay = Input filter time + 500 μSec maximum

Input Impedance



GFK-2796D

This product is intended only for industrial environments. Installation, commissioning, and maintenance shall be in accordance with the manual and carried out by qualified personnel. Refer to GFK-2314 for EMC installation and additional product information. Download at <http://www.geautomation.com/how-can-we-help-you>.

General Installation Conditions Of Safe Use

This product is considered open type equipment that shall be installed into an enclosure that provides minimum pollution degree 2 environment as defined by IEC60664-1. Unless instruction is provided, there are no field serviceable parts. Wiring connections shall use copper wire with minimum rating of 90 degrees Celsius. Where two wires are allowed the same wire type and size shall be used.

- IC693/IC694 IO terminals: One 14-22 AWG or two 16-22 AWG; 9.6-11.5 in. lb. (1.08-1.3 Nm) Torque

Installation In Hazardous Locations

Products bearing UL and ATEX marking are suitable for use in Class I Division 2, Groups A, B, C and D, and ATEX Zone 2 hazardous locations, or non-hazardous locations. Product shall be installed in an enclosure that is only accessible with the use of a tool.

WARNING – EXPLOSION HAZARD - WHEN IN HAZARDOUS LOCATIONS, TURN OFF POWER BEFORE WIRING or REPLACING MODULES, BATTERIES, BATTERY PACKS, FUSES, or ANY OTHER FIELD SERVICEABLE COMPONENT. SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY.

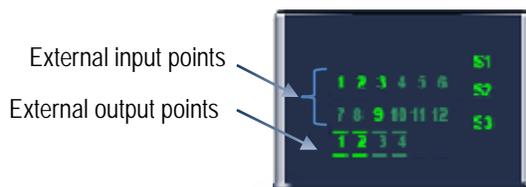
ATEX Zone 2

In addition to the above, the product shall be mounted in an enclosure certified for use in Zone 2, Group IIC, and rated IP54 minimum. Transient protection shall be provided at the input terminals set at a level 140% of rated. Markings as defined below.

 II 3 G Ex nA IIC T4 Gc X

Note: Temperature class varies per product. Refer to the product label.

Indicators



(S1) MODULE OK	GREEN	The High-speed Counter is powered up and has completed its internal diagnostics
	RED	The watchdog timer circuit has detected a module failure
	OFF	Module is not powered up correctly or internal diagnostics failed
(S2) CONFIG	ON	User configuration has been downloaded to the module
	OFF	Configuration has not been downloaded; the default configuration is in effect
(S3) FIELD POWER	ON	Output Field Power Present
	OFF	Output Field Power not present
(1 -12) INPUT STATUS	ON	Input is ON
	OFF	Input is OFF
(1-4) OUTPUT STATUS	ON	Output is ON
	AMBER	Output has overcurrent fault
	OFF	Output is OFF

Module Status Data

Enhanced Mode

In Enhanced mode, the Module Status data provides the CPU with 32 bits of diagnostic information about module operation.

Bit Field Name	Bit Number	Length	Default Value	Field Description
Module Ready	0	1 Bit	0	0 – Module Not Ready 1 – Module Ready
Reserved	1	1 Bit	0	Reserved
Field Power Status	2	1 Bit	0	0 – No Field Power Present 1 – Field Power Present
Reserved	3	1 Bit	0	Reserved
Command Error	4	1 Bit		0 – Command Error Has Not Occurred 1 – Command Error Has Occurred
Reserved	5	11 Bits	0	Reserved
Error Description	16	16 Bits	0	The module sets these bits to signal the user about a specific error condition that has occurred. For details, refer to the <i>PACSystems RX3i and Series 90-30 High-speed Counter Modules User Manual (GFK-0293)</i> or later.

Classic Mode

In Classic mode, Module Status data provides the CPU with 16 bits of diagnostic information about module operation.

Bit	Type A	Type B [†]	Type C [†]
1	Strobe 1 flag	Strobe 1.1 flag	Strobe 1.1 flag
2	Strobe 2 flag	Strobe 1.2 flag	Strobe 1.2 flag
3	Strobe 3 flag	Strobe 2.1 flag	Strobe 1.3 flag
4	Strobe 4 flag	Strobe 2.2 flag	Home Found
5	Preload 1 flag	Preload 1 flag	Preload 1.1 flag
6	Preload 2 flag	Preload 2 flag	Preload 1.2 flag
7	Preload 3 flag	Disable 1 status	Disable status
8	Preload 4 flag	Disable 2 status	Home Input status
9	Output 1 status	Output 1.1 status	Output 1.1 status
10	Output 2 status	Output 1.2 status	Output 1.2 status
11	Output 3 status	Output 2.1 status	Output 1.3 status
12	Output 4 status	Output 2.2 status	Output 1.4 status
13	Module Ready	Module Ready	Module Ready
14	always off	always off	always off
15	always off	always off	always off
16	Error flag	Error flag	Error flag

[†] A number in the format x.x identifies the counter and the element number. For example, Strobe 1.2 indicates Counter 1, Strobe 2.

GFK-2796D

Counter Status Data

Counter Status data indicates the status of counter operations. Depending on the type of counter some bits may not be used. Unused bits are always 0.

Bit Field Name	Bit Number	Length	Default Value	Field Description
Strobe 1 Status	0	1 Bit	0	0 – Strobe Has Not Occurred 1 – Strobe Has Occurred
Strobe 2 Status	1	1 Bit	0	
Strobe 3 Status	2	1 Bit	0	
Home Input Status	3	1 Bit	0	0 – No Home Input 1 – Home Input Present
Preload 1 Status	4	1 Bit	0	0 – Preload Has Not Occurred 1 – Preload Has Occurred
Preload 2 Status	5	1 Bit	0	
Disable Status	6	1 Bit	0	0 – No Disable Input 1 – Disable Input Present
Preset 1 Compare Status	7	1 Bit	0	0 – Preset is Off 1 – Preset is On
Preset 2 Compare Status	8	1 Bit	0	
Preset 3 Compare Status	9	1 Bit	0	
Preset 4 Compare Status	10	1 Bit	0	
Reserved	11	1 Bit	0	Reserved
Rollover Detection Flag	12	1 Bit	0	0 – Rollover Has Not Occurred 1 – Rollover Has Occurred
Reserved	13	2 Bits	0	Reserved
Home Found	15	1 Bit	0	0 – Home Not Found 1 – Home Found

Field Wiring

To meet the European EMC Directive requirements, shielded cable must be used for all cables connecting to the IC694APU300 High-speed Counter. The shielded cable must have a high frequency ground within 5.24 cm (6 in) of the IC694APU300 module. Refer to Appendix C in the *PACSystems RX3i System Manual (GFK-2314)* for cable clamping assembly to ground shielded cables. The length of the cable is limited to 30 m (98.43 ft).

Input Characteristics

The High-speed Counter uses single-ended positive logic (source) type inputs.

- Transducers with CMOS buffer outputs (74HC04 equivalent) can directly drive the High-speed Counter inputs using the 5V input range.
- Transducers using open collector outputs must include a 470 Ω pull-up resistor to 5 V to guarantee compatibility with the High-speed Counter inputs.
- Transducers using high voltage open collector (sink) type outputs must have a 1K pull-up resistor to +12 V for compatibility with the High-speed Counter 10 to 30 V input range.

Note: Classic versions of the APU300 required that transducers using TTL totem pole outputs include a 470 Ω pull-up resistor (to 5V) to guarantee compatibility with the High-speed Counter inputs. Enhanced (IC694APU300-CA and later) versions do not require a 470 Ω pull-up resistor with transducers using TTL totem pole outputs.

Input Voltage Ranges

The default voltage range is 10 to 30 V dc. To use this voltage range, leave the threshold selection terminals (pins 13 and 15) unconnected.

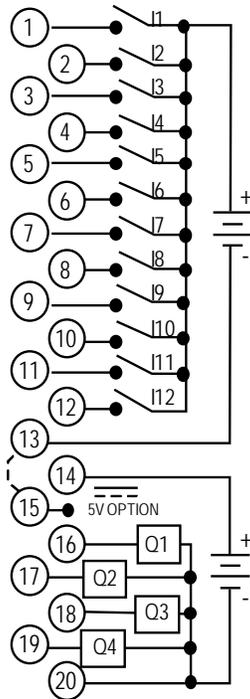
To select the 5 V dc threshold, connect a jumper between two terminals on the detachable terminal board connector.



Do not connect 10 to 30 V dc to the module inputs when the 5 V dc input range (pins 13 and 15 jumpered) is selected. Doing so will damage the module.

Caution

Terminals Field Wiring



GFK-2796D

Terminal Assignments for Each Counter Type

The following tables lists terminal block pin assignments based on the counter type combinations and input mode setting.

Enhanced Mode

Input	C1	C2	C3	C4	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12
Single Ended	A	A	A	A	A1	A2	A3	A4	PRELD1	PRELD2	PRELD3	PRELD4	STRB1	STRB2	STRB3	STRB4
Single Ended	B	-	B	-	A1	B1	A3	B3	PRELD1.1 [†]	DISAB1.1 [†]	PRELD3.1 [†]	DISAB3.1 [†]	STRB1.1 [†]	STRB1.2 [†]	STRB3.1 [†]	STRB3.2 [†]
Single Ended	C	-	-	-	A1	B1	A2	B2	PRELD1.1 [†]	PRELD2.2 [†]	DISAB1	HOME	STRB1.1 [†]	STRB1.2 [†]	STRB1.3 [†]	MARKER
Single Ended	A	A	B	-	A1	A2	A3	B3	PRELD1.1 [†]	PRELD2.1 [†]	PRELD3.1 [†]	DISAB3.1 [†]	STRB1.1 [†]	STRB2.1 [†]	STRB3.1 [†]	STRB3.2 [†]
Single Ended	A	A	Z	-	A1	A2	A3	B3	PRELD1.1 [†]	PRELD2.1 [†]	‡	‡	STRB1.1 [†]	STRB2.1 [†]	Z3.1 [†]	‡
Single Ended	B	-	A	A	A1	B1	A3	A4	PRELD1.1 [†]	DISAB1.1 [†]	PRELD3.1 [†]	PRELD4.1 [†]	STRB1.1 [†]	STRB1.2 [†]	STRB3.1 [†]	STRB4.1 [†]
Single Ended	B	-	Z	-	A1	B1	A3	B3	PRELD1.1 [†]	DISAB1.1 [†]	‡	‡	STRB1.1 [†]	STRB1.2 [†]	Z3.1 [†]	‡
Single Ended	Z	-	A	A	A1	B1	A3	A4	‡	‡	PRELD3.1 [†]	PRELD4.1 [†]	Z1.1 [†]	‡	STRB3.1 [†]	STRB4.1 [†]
Single Ended	Z	-	B	-	A1	B1	A3	B3	‡	‡	PRELD3.1 [†]	DISAB3.1 [†]	Z1.1 [†]	‡	STRB3.1 [†]	STRB3.2 [†]
Single Ended	Z	-	Z	-	A1	B1	A3	B3	‡	‡	‡	‡	Z1.1 [†]	‡	Z3.1 [†]	‡
Differential	A	-	A	-	A1+	A1-	A3+	A3-	PRELD1.1+	PRELD1.1-	PRELD3.1+	PRELD3.1+	STRB1.1+	STRB1.1-	STRB3.1+	STRB3.1-
Differential	B	-	-	-	A1+	A1-	B1+	B1-	PRELD1+	PRELD1-	DISAB1+	DISAB1-	STRB1.1+	STRB1.1-	STRB1.2+	STRB1.2-
Differential	Z	-	-	-	A1+	A1-	B1+	B1-	‡	‡	‡	‡	Z1+	Z1-	‡	‡

¹ Type B, Type Z counter:

A1, B1 are the A and B inputs for counter 1.

A3, B3 are the A and B inputs for counter 3.

² Type C Counter:

A1, B1 are the A and B count inputs for (+) loop

A2, B2 are the A and B count inputs for (-) loop

‡ No connection

[†] Inputs identified by two numbers separated by a decimal point indicate the counter number to the left of the decimal point and the element number on the right. For example, STRB1.2 indicates Counter 1, Strobe 2 input.

Classic Mode

Terminal	Signal Name	Pin Definition	Use in Counter Type		
			Type A	Type B ⁽¹⁾	Type C ⁽²⁾
1	I1	Positive Logic Input	A1	A1	A1
2	I2	Positive Logic Input	A2	B1	B1
3	I3	Positive Logic Input	A3	A2	A2
4	I4	Positive Logic Input	A4	B2	B2
5	I5	Positive Logic Input	PRELD1	PRELD1	PRELD1.1 †
6	I6	Positive Logic Input	PRELD2	PRELD2	PRELD1.2 †
7	I7	Positive Logic Input	PRELD3	DISAB1	DISAB1
8	I8	Positive Logic Input	PRELD4	DISAB2	HOME
9	I9	Positive Logic Input	STRB1	STRB1.1 †	STRB1.1 †
10	I10	Positive Logic Input	STRB2	STRB1.2 †	STRB1.2 †
11	I11	Positive Logic Input	STRB3	STRB2.1 †	STRB1.3 †
12	I12	Positive Logic Input	STRB4	STRB2.2 †	MARKER
13	INCOM	Common for positive logic inputs	INCOM	INCOM	INCOM
14	OUTPWR ⁽³⁾ DC+	Power for positive logic outputs	OUTPWR	OUTPWR	OUTPWR
15	TSEL	Threshold select, 5V or 10 to 30V	TSEL	TSEL	TSEL
16	O1	Positive Logic Output	OUT1	OUT1.1 †	OUT1.1 †
17	O2	Positive Logic Output	OUT2	OUT1.2 †	OUT1.2 †
18	O3	Positive Logic Output	OUT3	OUT2.1 †	OUT1.3 †
19	O4	Positive Logic Output	OUT4	OUT2.2 †	OUT1.4 †
20	OUTCOM DC-	Common for positive logic outputs	OUTCOM	OUTCOM	OUTCOM

¹⁾ Type B counter:

A1, B1 are the A and B inputs for counter 1.

A2, B2 are the A and B inputs for counter 2.

²⁾ Type C Counter:

A1, B1 are the A and B count inputs for (+) loop

A2, B2 are the A and B count inputs for (-) loop

³⁾ OUTPWR **does not** source power for user loads. Output power **must be supplied** from an external supply.

† Inputs and outputs identified by two numbers separated by a decimal point indicate the counter number to the left of the decimal point and the element number on the right. For example, STRB1.2 indicates Counter 1, Strobe 2 input.

GFK-2796D

Release History

Version	Firmware Release	Date	Description
IC693APU300-PC	-	Nov 2015	Hardware release only. New hardware replaces the existing hardware revision in production after full consumption of previous revision FAB boards (C0 rev). This is applicable for both Rx3i and 90-30 systems.
IC694APU300-DC	1.10	Oct 2014	Resolves issue of reading counter value incorrectly.
IC694APU300-DB	1.01	July 2014	Hardware upgrade only. Addresses issues related to output behaviour at elevated temperatures. Field modification cannot be performed in the field.
IC694APU300-CB	1.01	June 2013	Resolves an issue where using the internal oscillator in Classic mode generated a measurement error.
IC694APU300-CA	1.00	Aug 2012	Adds <i>Enhanced mode</i> features for use in RX3i systems. Hardware update to resolve component obsolescence issues.

Important Product Information**Upgrades**

Note: Only APU300 modules in RX3i racks support firmware upgrades in the field. The firmware of APU300 modules cannot be upgraded in Series 90-30 systems.

An upgrade kit containing firmware version 1.10 (41G1606-MS10-000-A2), is available for download at <http://ge-ip.com/support>.

Compatibility

Programmer version requirements	
Classic mode	Any version of Proficy Machine Edition
Enhanced mode	Proficy Machine Edition version 7.00 SIM 10 or later
CPU requirements	
Classic mode	Any Series 90-30 or RX3i CPU
Enhanced mode	RX3i CPU315, CPU320, CRU320, NIU001+, CPE305 or CPE310 with firmware version 7.13 or later

Notes: The IC694APU300-Cx and later modules do not support the Hand-held Programmer.

A Loss of I/O Module fault can occur in a Series 90-30 system having IC693CPU331-CD or earlier with the new APU300 module. To avoid this fault, IC693CPU331 should be upgraded to revision CE or later.

Problems Resolved by this Revision

IC694APU300 is not reading the counter value correctly.

This issue was observed due to rare timing error in the firmware and FPGA interface.

Restrictions and Open Issues

Subject	Description
Outputs may fail when user supplied field power is more than 30 V dc	With IC694APU300-Cx, when the user supplied field power exceeds 30 V dc then the outputs may fail.
In boot firmware mode the module logs Loss of IO module faults continuously.	During indirect firmware update process, should the operation be disrupted (for example by a power cycle or the serial cable is disconnected) the module will enter boot firmware mode (S1 and S2 LEDs blink in unison continuously). If hardware configuration is downloaded from Proficy Machine Edition at this point and the module is configured as Enhanced mode, the IO Fault table is flooded with Loss of IO Module faults. To correct this problem, clear the hardware configuration from CPU before restarting the firmware update process.

Operational Notes

- When both COMMREQ and memory mapping methods are used to update the same variable, the result will be indeterminate, as the last command accepted by the module will be that which will affect the outcome.
- During Indirect firmware update process, if the operation is disrupted (such as with a power cycle or the serial cable is disconnected), the module switches into boot mode (S1 and S2 LEDs blink in unison continuously).
 - If the module is configured as Classic mode in the hardware configuration, restart the firmware update process to complete the firmware upgrade.
 - If the module is configured as Enhanced mode, Loss of I/O Module fault will be logged in the I/O Fault table.
 - **To recover from the Loss of I/O Module fault**
 1. Clear the hardware configuration from CPU memory – RAM and Flash(if the hardware configuration is stored in Flash).
 2. Power cycle the system.
 3. Restart the firmware update process.
 4. After the firmware update is complete, restore the hardware configuration in the CPU memory.
- IC694APU300 does not support the 90-30 Hand Held programmer.