February 2002
GFK-1465E

IMPORTANT PRODUCT INFORMATION

READ THIS INFORMATION FIRST

Product: IC693 DSM Module ("DSM302") with Firmware Version 1.41
IC693DSM302-AF

Introduction

Some of the information in this document is not available elsewhere, so we recommend you save it for future reference. This document covers the following subjects:

- Basic features of the DSM302 module.
- Special Operational Notes
- Problems resolved in the latest firmware release, version 1.41.
- Problems resolved and new features in previous firmware versions.

Basic Features of the DSM302

Product Description

The DSM302 Module is a two-axis motion control module, which is highly integrated with the logic solving and communications functions of the IC693 PLC. Two primary control loop configurations are provided: Standard mode and Follower mode. The basic capabilities of the DSM302 are described below:

Performance

- Digital Signal Processor (DSP) provides vector control of GE Fanuc AC servos
- Servo loop update:
  - Digital Mode: 250 µSec (torque), 1 mSec (velocity), 2 mSec (position)
  - Analog Mode: 2 mSec (position)
- Block processing time under 5 mSec
- Velocity Feed Forward and Position Error Integrator to enhance tracking accuracy
- High resolution of programming units:
  - Position: –8,388,608 . . . +8,388,607 User Units
  - Velocity: 1 . . . 8,388,607 User Units / sec
  - Acceleration: 1 . . . 134,217,727 User Units / sec / sec

Ease of Use

- Simple and powerful instruction set
- One-axis or two-axis motion programs with synchronized block start
- Program support for a short motion program (called Program Zero) that can be created in the MS-DOS® programming software configuration function
- Nonvolatile (flash) storage for 10 programs and 40 subroutines
- User scaling of programming units (in Standard mode only)

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- Generic programming using command parameters as operands for Acceleration, Velocity, Move, and Dwell commands
- Configured with a variety of MS-DOS or Windows configuration software
- Automatic data transfer between PLC tables and the DSM302 without user programming
- Ease of I/O connection with factory cables and terminal blocks as well as a serial port for connecting programming devices

Versatile I/O

- Control of Digital AC servos and Analog servos with ± 10v Velocity Command Interface.
- Home and overtravel switch inputs for each servo axis
- Two position capture strobe inputs for each position feedback input
- 5v, 24v and analog I/O for use by the PLC
- Incremental quadrature encoder input for Follower mode master axis
- 13-bit analog output for each auxiliary axis can be controlled by PLC or used as servo tuning monitor

Product ID

IC693DSM302-AE

- Hardware ID: AP3B1 (44A737294-G01R03 or later)
- Software ID: Firmware version 1.41 Boot: 44P725986-408B
  App: 44S750607-G01R06

Firmware Update Kit

44A732298–G05 (firmware version 1.41)

Applicable Documents

DSM302 for IC693 PLCs User's Manual
IC693PLC Axis Positioning Module (APM) Programmer's Manual

Special Operational Notes

IC693 CPU Firmware

Use of DSM302 firmware version 1.41 requires that the associated IC693 CPU be equipped with version 6.50 or higher of the CPU firmware.

Motion Programmer

Motion programs 1-10, if required, must be created/edited with separate Motion Programmer software. DSM302 firmware version 1.41 requires that version 1.50 or higher of the APM300 MS-DOS Motion Programmer software be used.

Configuration

Configuration Software Requirements

The DSM302 (firmware version 1.41) may be configured with any of the following software products:

- Version 8.02 or higher of the MS-DOS Programming Software will allow basic configuration. However, version 9.00 or higher of the MS-DOS Programming Software is required to fully configure the expanded A/B ratio feature (see the "Expanded Follower A/B Ratio" subject in the "Features and Functionality Introduced in Release 1.20" section later in this document).
- Any version of the Windows®-based programming/configuration products.

Essential Configuration Parameters

The following configuration parameters will not default to the settings required for many applications and must be changed by the user.

Caution

***Fdback Type* and *Ctl Loop* MUST be changed first. Any change to either *Fdback Type* or *Ctl Loop* resets all other parameters to default values.**

AI/AQ Len:	Set according to the minimum requirements of your application. Setting 40/6 can be used for Standard mode. Follower mode requires at least setting 50/9 if Master Axis position and velocity are to be monitored by the PLC. Setting 64/12 provides the maximum amount of analog I/O references.
Fdback Type:	Must be changed to DIGITAL for digital servos or ENCODER for analog servos. Feedback types LINEAR, RESOLVR, CUSTOM1 and CUSTOM2 are not supported in this release of the firmware.
Ctl Loop:	Select STANDARD for Standard control loop mode or FOLLOWER for Follower control loop mode. CCL2 is reserved for special applications. CCL1 is not supported in this release.
Servo Cmd:	Must be changed to DIGITAL or ANALOG. DUAL mode is not supported in this release.
Motor1 Type, Motor2 Type:	For Digital servos, must be changed to the correct motor type. Select type 0 if either no servo is used or if ANALOG mode is used.
Pos Err Lim:	Change from default setting of 4096 to a typical value of 15000 – 30000.
Pos Loop TC:	Change from default setting of 1000 ms to a typical value of 30 – 50 mSec.
Vel at 10v:	Must be changed to : 139,820 (User Units / Counts) for Digital servos. Reference the DSM manual, Revision B, for correct Analog servo settings.

Configuration NOTEQ (Not Equal)

When a rack configuration containing a DSM302 module is stored (downloaded) to an IC693 PLC CPU with a firmware revision earlier than 8.10, the MS-DOS-based programmer status area will still show CONFIG NOTEQ even though the store operation completes successfully. If the configuration is immediately loaded back into the MS-DOS programming software, the status area will then show the expected CONFIG EQUAL. The status area will continue to show the correct CONFIG EQUAL setting until a new configuration is again stored to the PLC CPU.

PLC %Q Bits

PLC %Q bits are, by design, RETENTIVE in nature. These bits ONLY become NON-RETENTIVE after the location is used (programmed) in a PLC program. All motion-causing %Q bits such as *Drive Enable*, *Start Motion program*, *Jog*, etc. must be controlled from a "programmed" PLC coil reference for safe operation.

Grounding Bars and Clamps

The *DSM302 for IC693 PLCs User's Manual* describes the I/O cable grounding requirements necessary for a system to meet CE Mark installation guidelines. These guidelines include the use of grounding bars and clamps, both of

which are available from your distributor. The Grounding Bar may be ordered as part number 44B295864-001R02, and the Ground Clamp as part number A99L-0035-0001.

Cables

Five different cables are available for use with the DSM302, as described below. Consult the factory regarding custom length cables.

- IC693CBL324: 1 meter terminal board connection I/O cable
- IC693CBL325: 3 meter terminal board connection I/O cable
- IC800CBL001: 1 meter servo command cable
- IC800CBL002: 3 meter servo command cable
- IC693CBL316: Motion programmer communications cable

Caution

The I/O and command cables listed above are custom manufactured with special shielding and internal construction. Substituting non-approved cables may adversely affect the servo system.

Terminal Boards

Two terminal boards for user I/O connections are available for use with the DSM302, as described below.

- IC693ACC335: Servo Axis terminal board
- IC693ACC336: Auxiliary terminal board

These terminal boards provide screw terminal connections for I/O signals such as Position Strobes, Home Switches, Limit Switches, Analog Inputs and Analog Outputs. For additional information, refer to Chapter 3 and Appendix E of the *DSM302 for IC693 PLCs User's Manual.*

Caution

The terminal blocks contain Metal Oxide Varistor (MOV) circuit protectors, which prevent excessive electrical energy from affecting the DSM302. The maximum recommended input voltage for any of the 24v I/O circuits is 30 VDC with respect to earth ground ("S" terminal) or circuit common.

Strobe Input Differences between Analog and Digital Mode

The strobe input faceplate pins for Axis 1 and Axis 2 depend on the DSM servo mode (Analog or Digital). In Digital Mode, the Axis 1 and 2 strobe inputs use faceplate inputs IN1 and IN2, which can be either single ended or differential. In Analog mode, the Axis 1 and 2 strobe inputs use faceplate inputs IO5 and IO6 which are single ended only. Axis 3 always uses IO5 and IO6 as the strobe inputs.

NOTE

The input circuits for IO5 and IO6 contain 4.7k pull-up resistors to internal +5v. If no signal is connected to these inputs, the input will always appear to be ON. Normally a single ended TTL or CMOS driver must be used to drive these circuits from the strobe sensor.

The strobe inputs are summarized in the table below.

Servo Type	**Axis 1 Strobe Inputs**	**Axis 2 Strobe Inputs**	**Axis 3 Strobe Inputs**
Analog	IN1_A, IN2_A (Single Ended or Differential)	IN1_B, IN2_B (Single Ended or Differential)	IO5_C, IO6_C (Single Ended)
Digital	IO5_A, IO6_A (Single Ended)	IO5_B, IO6_B (Single Ended)	IO5_C, IO6_C (Single Ended)

Problems Resolved by this Firmware Release (1.41)

Drive Disable Delay (DisDly) timeout parameter functions incorrectly when configured to values less than 8ms.

The Drive Disable Delay parameter controls the time the motion controller performs regenerative braking versus dynamic braking. Prior to the Drive Disable Delay timeout, dictated by the parameter in question, the control uses regenerative braking. After the Drive Disable Delay timeout period expires, the control switches modes to dynamic braking.

However, in firmware versions prior to release 1.41, if the Drive Disable Delay time is set to a value less than 8ms, the motion controller does not switch from the regenerative braking mode to the dynamic braking mode, leaving the motion controller to stop the motor shaft by using only the regenerative braking mode. While in this state, if there is an external force applied to the static motor shaft, motor current will flow in the motor/amplifier set. If enough force is applied for a sufficient period of time, this can cause a failure in the regenerative power resistors on the amplifier.

This issue has been corrected in firmware release 1.41. With this release, the controller will switch from the regenerative braking mode to the dynamic braking mode even if the Drive Disable Delay is set to a value less than 8ms.

Caution

Be aware that if you upgrade a DSM302 to release 1.41 in a system where the Drive Disable Delay parameter is already configured to less than 8ms, the braking characteristic of the system will change. This change is related to how the motor will stop, since the DSM will now switch from the regenerative braking mode to the dynamic braking mode.

Problems Resolved by Firmware Release 1.40

EN3/EN4 LEDs Flash when Performing Slow Jog Function

When performing a slow jog, LEDs EN3 and EN4 incorrectly flashed. The problem was caused by an internal Axis-3/Axis-4 AQ processing error. The result was, that if the DSM configuration used 6 or 9 AQ words, the Force D/A command for Axis-3 and Axis-4 operated incorrectly. This has been corrected in firmware version 1.40, such that the error no longer occurs.

Problems Resolved by Firmware Release 1.30

AQ Command 30h Causes Module to "Crash"

Issuing an AQ command of 30h (Set Internal Master Velocity in Follower), to a value larger that 32,767,999 generated a fatal error (NMI generated/watchdog timeout). This was fixed in firmware version 1.30. Error checking was added to generate a warning when values outside the valid range (-1,000,000 … +1,000,000 counts/sec) are entered. If values outside the valid range are entered, the command is ignored and error code01E9 (for Axis 1) or 02E9 (for Axis 2) is reported.

IPI for Release 1.20 Contained Inaccurate Encoder Position Resolution Data

The description for the Enhanced Position Loop Resolution function description was not clear. The description was improved in the IPI for release 1.30.

Turn off "CONFIG LED" when Flashing Error Code

A fatal error did not turn off the "CONFIG LED" when a fatal error code occurs. Firmware version 1.30 was updated to turn off the "CONFIG LED" when a fatal error code is issued.

Jog Vel-User Units-Counts Configuration Value Causes Module to "Crash"

Configuring the module for User Units to Counts ratio of greater than 1:3, and Jog Vel = 8,388,607 caused a fatal error (NMI generated/watchdog timeout). Firmware version 1.30 was enhanced to internally limit the Jog Velocity to 1,000,000 (count/sec). If the module is configured to a number greater than 1,000,000 (counts/sec), the module uses the maximum jog velocity of 1,000,000 (count/sec).

Follower Deceleration Ramp Reentry after Drive off/on

In follower mode, if follower is disabled and then the drive is disabled, motion will stop. However, the module continues to calculate the deceleration ramp while the follower is disabled. If the deceleration ramp has not reached zero prior to the drive being re-enabled, the module will issue a velocity command corresponding to the current deceleration ramp value and complete the deceleration ramp. This was corrected in firmware version 1.30, such that the deceleration ramp is not re-entered.

Problems Resolved by Firmware Release 1.20

Input IN4_C Does Not Function As Described

The on/off state of the IN4_C input (see GFK-1464, *DSM302 for IC693 PLCs User's Manual*, chapter 5, "DSM302 to PLC Interface," for details) was inverted from what was documented. This was corrected in firmware version 1.20, such that the on/off state of the input matches the documentation.

Firmware Reports D6 Error Sporadically during Normal Operation

Previous firmware contains an error that causes a D6 error to be reported incorrectly during normal operation. The nature of the firmware error also causes errors D3-D9 to be reported incorrectly. These firmware errors were fixed in version 1.20.

Documentation Issues in *DSM302 for IC693 PLCs User's Manual*, Resolved by Revision A (May 1998) Release

The following table outlines the previously identified documentation issues that have been resolved by the revision A release of GFK-1464*, DSM302 for IC693 PLCs User's Manual:*

Issues Resolved by Revision A (May 1998 Release)

Documentation Issue	Location	Description/Resolution
PCR Connectors Mislabeled in Pin Configuration Diagrams	Chapter 2	Two different connector pin configurations for the emergency stop JX5 connector on the β Series servo amplifier were shown with the labels (HIROSE and HONDA) incorrectly reversed. The labels were switched.
Grounding Bars and Clamps Need to Be Documented	Chapter 3	The "I/O Cable Grounding" section did not specify the part numbers for the grounding bars and clamps needed for proper installation. These have been added to the manual.
Quadrature Specifications Not Documented	Chapter 3	The technical specifications for quadrature devices used as a follower master axis were not documented. These have been added to the manual.
Incorrect Part Numbers Listed for Terminal Block Connection Cables	Chapter 3	The incorrect part numbers were given for the Terminal Board Connection cables. The incorrect part numbers listed were IC800CBL324 and IC800CBL325. These part numbers should have been IC693CBL324 and IC693CBL325, respectively, and have been corrected.
Input IN4_C Wiring Not Described	Chapter 3	The appropriate wiring for input IN4_C was not described. The description has been added.
Final Home Velocity Valid Command Range Incorrectly Specified	Chapter 4	The "Configuring the DSM302" section incorrectly specified the valid range as 1..8,388,607. The range is actually 1..65535 and has been corrected in the manual.
Select Return Data Command Incorrectly Described	Chapter 5	Section incorrectly stated that information is returned in the *Commanded Position* %AI word for each axis. Data is actually returned via the *User Selected Data* %AI word for each axis. Text has been corrected.
Wrong Graphic Used for Velocity Profile	Chapter 7, Figure 7-6	Figure showed an expected velocity profile for a program example describing "hanging" the DSM302 when distance runs out. The incorrect graphic that was included has been replaced with the correct one.
Error Code 35 Not Documented	Appendix B	Axis status error code 35 was not documented. This error is now correctly described as a "find home while follower enabled" error.
Wire Size, Screw Torque and MOVs for Terminal Blocks Not Specified	Appendix E	The wire size, screw torque and MOV descriptions for terminal block assemblies IC693ACC335 and IC693ACC336 were not specified. These descriptions have been added.

Problems Resolved by Firmware Release 1.10

Encoder 3 Home Position

During a *Find Home* cycle on the Aux 3 axis, the Encoder 3 home position was not registered correctly in firmware version 1.00 when the encoder marker pulse was sensed. This was corrected in firmware version 1.10. Note that this problem only pertained to Follower mode operation.

Module Sometimes Halted Responding to COMMREQ Commands

When the DSM module was receiving a high rate of COMMREQ commands from the PLC CPU and was simultaneously executing a series of short move commands, the module would sometimes halt execution and flash a 6-count/ 7-count error code on its STAT LED (see Appendix B of GFK-1464, *DSM302 for IC693 PLCs User's Manual,* for details). This timing problem was corrected in firmware version 1.10.

Features and Functionality Introduced in this Release (1.41)

Release 1.41 has no new features. The purpose of this release is to resolve the problem described in the section "Problems Resolved by this Firmware Release (1.41)."

New Features and Functionality Introduced in Release 1.40

DSM Analog Mode

The current DSM module is enhanced in firmware version 1.40 to provide an analog servo interface. The controller provides a ± 10 volt analog velocity command interface signal. The analog interface supports third party motor/amplifier sets that support a ± 10 volt velocity command and a quadrature encoder position feedback interface. The function is currently implemented in the APM product line and allows the DSM to support the same motors and amplifiers as the existing APM controller.

Enhanced Follower Accuracy

The DSM follower feature accuracy is enhanced in DSM firmware version 1.4. In Follower mode, the master axis position is sampled 1.0 mSec to 1.5 mSec prior to using the data within the control. This sampling delay causes the follower slave axis to have a measurable and predictable (based upon motor velocity) following error. To address the delay, a master axis position delay compensation has been added in release 1.4. The delay compensation uses the master axis velocity to correct the follower master position and eliminate the following error due to master axis sampling delay.

Features and Functionality Introduced in Release 1.30

Enhanced %AI and %I Processing

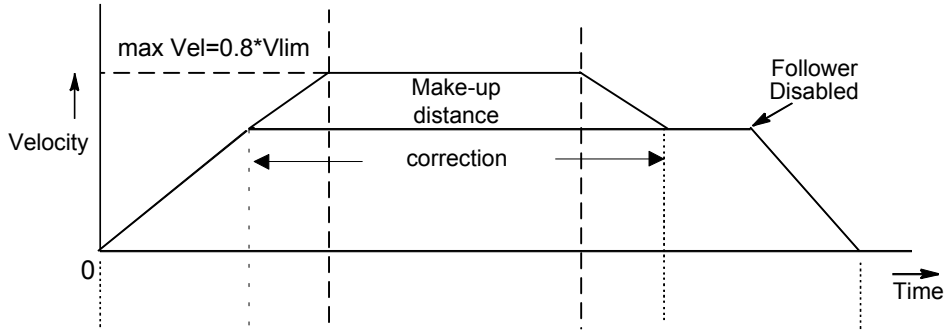
The internal DSM update rate for %I data and %AI data (except for the *Actual Velocity* data) has been increased from once every 10 milliseconds to once every 2 milliseconds. *Actual Velocity* data is updated every 128 milliseconds.

Enhanced Follower Axis Ramp Control

The Follower Axis Ramp Control Function is enhanced in DSM firmware release 1.30. The enhancement improves motion smoothness. Prior to this release, when the follower was active and the master in motion, the acceleration/deceleration control during the make-up correction phase was not controlled by a velocity profile. This could cause unwanted machine shock. The enhanced method uses a trapezoidal velocity profile to address this problem. During the entire make-up correction phase, the acceleration/deceleration is limited to the jog acceleration value. Also during the correction, the velocity is not allowed to exceed the maximum. Appropriate warning/error codes notify the user about abnormal operation (see error table below).

Error Number (Hexadecimal)	Response	Description	Error Type
EA	Status Only	Master velocity greater than 0.8*velocity limit-no distance compensation	Axis
EB	Fast Stop	Error in calculation during ramp-up	Axis
EC	Status Only	Programmed makeup time is not long enough for trapezoidal correction of the makeup distance	Axis
ED	Status Only	Velocity limit violation during ramp	Axis
EE	Status Only	Time limit violation during acceleration sector of the distance correction	Axis

The figure below shows the velocity profile during the follower ramp cycle. *Note: The enhanced follower make-up may affect existing applications that use the old follower make-up feature.*



Features and Functionality Introduced in Release 1.20

Expanded Follower A/B Ratio

The A/B slave/master follower ratio has been expanded from the original range of 32:1 to 1:32 to a range that supports 32:1 to 1:10,000. Existing AQ command 2Dh can be used to specify an expanded range at runtime. Specifying the expanded range (ratio greater than 1:32) at configuration time requires release 9.0 or higher of the MS-DOS Programming Software, or Windows-based Programming Software release 2.11 or higher.

Enhanced Position Loop Resolution

Enhanced position loop resolution, at the expense of maximum supported motor velocity, was added to the product in firmware release 1.20. Prior to this release, a non-configurable position loop resolution of 8192 counts per encoder revolution was provided. The table below describes the various selections now supported, along with the maximum supported motor velocity for each setting. Note that the configuration data is specified by entering a value of "1" (to select parameter 1) in the "Tuning Par1" or "Tuning Par2" field of the Axis-1 screen for axis-1 or Axis-2 screen for axis-2. The appropriate resolution setting value (0..3) is then entered in the corresponding "Tuning Dat1" or "Tuning Dat2" field in the Axis-1 screen for axis-1 or Axis-2 screen for axis-2.

Enhanced Position Loop Resolution Selections Supported

Encoder Resolution (in Counts per Revolution)	Maximum Motor Velocity (Revolutions per Minute)	Configuration Data	
		Parameter #	Value
8192 cts/rev	4400 rpm[1,2]	1	0
16384 cts/rev	3662 rpm[2]	1	1
32768 cts/rev	1831 rpm	1	2
65536 cts/rev	915 rpm	1	3

[1] Default Setting.
[2] Some motors are restricted to a lower maximum rpm rating.

Features and Functionality Introduced in Release 1.10

HV Motors

Support for the following three HV motors was added in firmware release 1.10:

Motor Model	Motor Type Code
α12HV/3000	3
α22HV/3000	4
α30HV/3000	5

Set Aux Axis 3 Position Command Enhancement

The *Set Aux Axis 3 Position* command was enhanced to execute regardless of the axis' current velocity. In firmware version 1.00, the command would be ignored and a 0X52 axis status error reported if the axis' velocity exceeded 128 counts per second.

Restrictions and Open Problems

Restriction/Problem	Description
Axis Mode = LINEAR may not operate correctly if ***Pos EOT* = *Hi Limit*** or ***Neg EOT* = *Lo Limit***	If ***Axis Mode*** = LINEAR, the axis will stop at the configured Positive / Negative End of Travel limits if these values equal the corresponding Hi / Lo Count Limits. However, you may not be able to jog back off the EOT. To avoid this problem when using ***Axis Mode*** = LINEAR, always set ***Pos EOT*** below (to a lower value than) the ***Hi Limit*** and ***Neg EOT*** above (to a higher value than) the ***Lo Limit***. For example, if the ***Hi Limit*** was set to +1000, and the ***Low Limit*** to –1000, the ***Pos EOT*** could be set to +990, and the ***Neg EOT*** to –990.
Axis Mode = LINEAR should not be selected when ***Ctl Loop*** = FOLLOWER	In Follower Mode, if the ***Axis Mode*** is set to LINEAR, the ***Pos EOT / Neg EOT*** values are internally set to the corresponding Hi/Lo Count Limits. Because of the problem listed above, a *Jog* or programmed Move may not work at the configured EOT limit. In addition, the EOT limits do not apply to motion generated by Follower Master Axis inputs. Therefore ***Axis Mode*** = LINEAR should not be selected for either servo axis when ***Ctl Loop*** = FOLLOWER.
MCON can be left enabled when aborting a Jog	If the following sequence is followed exactly, MCON will be left on in error following the cessation of all motion: Begin a Jog operation, turn on the abort bit to abort the jog, turn off the jog bit, wait for motion to completely stop, then turn off the abort bit.
Return Data Selector does not work if Motor Type = 0.	In digital mode with Motor Type = 0, the "User Selected Return Data" for that axis no longer operates. Thus, with Motor Type = 0, the user will not be able to view data such as the firmware revision number.
Follower master velocity is not initialized during 6 ms after follower disabled.	Follower axis may jump during the first cycle after the follower is disabled when configured for ACC RAMP. This is due to a 6 ms delay in master velocity initialization in the master velocity-smoothing algorithm.