

IOS-445 32 Channel Isolated SSR Output Module

# **USER'S MANUAL**

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# IMPORTANT SAFETY CONSIDERATIONS

It is very important for the user to consider the possible adverse effects of power, wiring, component, sensor, or software failures in designing any type of control or monitoring system. This is especially important where economic property loss or human life is involved. It is important that the user employ satisfactory overall system design. It is agreed between the Buyer and Acromag, that this is the Buyer's responsibility.

# 1.0 GENERAL INFORMATION

The I/O SERVER MODULE (IOS) Series IOS-445 module is a bus isolated 32-channel output module. The IOS-445 provides control for 32 solid state relays which are bipolar and may be used to switch positive or negative voltages. Four units may be mounted on a carrier board to provide up to 128 channels of output control in a single system slot. The IOS-445 offers a variety of features which make it an ideal choice for many industrial and scientific applications as described below.

**Important Note:** The following IOS model are accessories to the IOS Server Models: IOS-7200, IOS-7200-WIN, IOS-7400, and IOS-7400-WIN; which are cULus Listed. This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

MODEL	OPERATING TEMPERATURE RANGE
IOS-445	-40 to +85°C

#### **KEY IOS-445 FEATURES**

- High Channel Count Individual control of up to 32 (SPST-NO) bipolar Solid State Relays (SSR's) is provided. Four units mounted on a carrier board provide 128 channels in a single system slot.
- **Optically Isolated** Individual bipolar SSR's provide isolation. The IOS-445 contains four groups (ports) of eight channels which include separate port commons to ensure port to port isolation. Individual ports are isolated from each other and from the IOS logic.
- Low-Side or High-Side Switch Configuration Each group of eight channels can be connected directly to positive or negative supplies for high (hot) side switching. Alternatively, each group of eight channels can be connected to common for low side switching. Socketed pull-up resistors are provided for low side switching applications.
- **TTL Compatible** When configured as a low side switch will sink 27mA at 0.4 volts. Sourcing is controlled by the installed pull-up resistor.
- Power Up & System Reset is Fail-safe For safety, the outputs are turned OFF upon power-up and a system reset. Thus, the SSR's will be disabled after a power-up or system reset.
- Wide Range Bipolar Voltage Outputs Outputs are rated from 0 to ±60 volts. The bipolar solid state relays allow both AC and DC switching.
- Output Readback Function Readback buffers are provided that allow the output channel registers to be read back.
- Loopback Compatible with IOS-440 Digital Input Module -The P2 field I/O pin assignments of the IOS-445 output module correspond with those of the Acromag IOS-440 Bus Isolated Input module. This provides direct closed-loop monitoring of the output states.

- No Configuration Jumpers or Switches All configuration is performed through software commands with no internal jumpers to configure or switches to set.
- Conduction Cooled Module I/O modules employ advanced thermal technologies. A thermal pad and module cover wicks heat away from the module and transfers the energy to a heat spreading friction plate. Heat moves to the enclosure walls where it is dissipated by the external cooling fins.

## I/O SERVER MODULE INTERFACE FEATURES

- **High density** Single-size, IOS module footprint. Four units mounted on a carrier board provide up to 128 isolated output points in a single system slot.
- Local ID Each IOS module has its own 8-bit ID signature which can be read via access to the ID space.
- 8-bit I/O Port register Read/Write is performed through 8 or 16-bit data transfer cycles.

#### I/O SERVER MODULE SOFTWARE LIBRARY

# IOS MODULE Win32 DRIVER SOFTWARE

Acromag provides a software product (sold separately) to facilitate the development of Windows Embedded Standard applications interfacing with I/O Server Modules installed on Acromag Industrial I/O Server systems. This software (Model IOSSW-DEV-WIN) consists of a low-level driver and Windows 32 Dynamic Link Libraries (DLLS) that are compatible with a number of programming environments including Visual C++, Visual Basic.NET, Borland C++ Builder and others. The DLL functions provide a high-level interface to the IOS carrier and modules eliminating the need to perform low-level reads/writes of registers, and the writing of interrupt handlers.

# IOS MODULE LINUX SOFTWARE

Acromag provides a software product (sold separately) consisting of Linux® software. This software (Model IOSSW-API-LNX) is composed of Linux libraries designed to support applications accessing I/O Server Modules installed on Acromag Industrial I/O Server systems. The software is implemented as a library of "C" functions which link with existing user code.

# 2.0 PREPARATION FOR USE

#### UNPACKING AND INSPECTION

Upon receipt of this product, Inspect the shipping carton for evidence of mishandling during transit. If the shipping carton is badly damaged or water stained, request that the carrier's agent be present when the carton is opened. If the carrier's agent is absent when the carton is opened and the contents of the carton are damaged, keep the carton and packing material for the agent's inspection.



For repairs to a product damaged in shipment, refer to the Acromag Service Policy to obtain return instructions. It is suggested that salvageable shipping cartons and packing material be saved for future use in the event the product must be shipped. This board is physically protected with packing material and electrically protected with an anti-static bag during shipment. However, it is recommended that the board be visually inspected for evidence of mishandling prior to applying power.

The board utilizes static sensitive components and should only be handled at a static-safe workstation. **BOARD CONFIGURATION** 

Power should be removed from the board when installing IOS modules, cables, termination panels, and field wiring. Refer to your IOS module documentation for configuration and assembly instructions. Module IOS-445 digital output boards have no hardware jumpers or switches to configure. Software configurable control registers are provided for control of all modes of operation. Refer to section 3 for programming details.

This module is built with socketed output pull-up resistors installed. These may be used when the SSR's are applied as low side switches. Resistor values may be changed if needed, and the resistors may be removed for high side switching (see IOS-445 RESISTOR LOCATION DRAWING).

#### CONNECTORS

#### IOS Field I/O Connector (P2)

P2 provides the field I/O interface connections for mating IOS modules to the carrier board. P2 is a 50-pin female receptacle header (AMP 173279-3 or equivalent) which mates to the male connector of the carrier board (AMP 173280-3 or equivalent). This provides excellent connection integrity and utilizes gold-plating in the mating area. The field and logic side connectors are keyed to avoid incorrect assembly.

P2 pin assignments are unique to each IOS model (see Table 2.1) and normally correspond to the pin numbers of the field I/O interface connector on the carrier board (you should verify this for your carrier board).

Pin Description	Number		Pin Description	Nun	nber
OD00	1		OD20	26	Р
OD01	2		OD21	27	0
OD02	3	Р	OD22	28	R
OD03	4	0	OD23	29	Т
User Supply 0	5	R	User Com Out 2	30	2
OD04	6	т	OD24	31	
OD05	7		OD25	32	
OD06	8	0	OD26	33	Р
OD07	9		OD27	34	0
User Com Out 0	10		User Supply 3	35	R
OD08	11		OD28	36	т
OD09	12		OD29	37	
OD10	13	Р	OD30	38	3
OD11	14	0	OD31	39	
User Supply 1	15	R	User Com Out 3	40	
OD12	16	Т	Not Used	41	
OD13	17		Not Used	42	
OD14	18	1	Not Used	43	
OD15	19		Not Used	44	
User Com Out 1	20		Not Used	45	
OD16	21	Ρ	Not Used	46	
OD17	22	0	Not Used	47	
OD18	23	R	Not Used	48	
OD19	24	Т	Not Used	49	
User Supply 2	25	2	Not Used	50	

Table 2.1: IOS-445 Field I/O Pin Connections (P2)

The output channels of this module are divided into four ports of eight channels each. All channels within a port share a common signal connection with each other. Isolation is provided between the ports and the IOS logic which includes the remainder of the I/O Server. In addition, bus isolation is provided between ports.

P2 pin assignments are arranged to be compatible with similar Acromag models. This model is directly loopback compatible with the Acromag Model IOS-440 32-Channel Digital Input Board. Likewise, pin assignments are identical to those of Acromag Model IOS-405 40-Channel Digital Output Boards for channels 0-31, except for the user supply connections.

See IOS-440/IOS-445 LOOPBACK CONNECTIONS for loopback connections to Acromag Model IOS-440 Input Modules.

Note that the outputs of this module are bipolar, and may be connected in any direction with respect to the port common. Further, do not confuse port commons with signal ground. For the IOS-445, port common only infers that this lead is connected common to the 8 outputs of the port (a separate common for each port). The port commons of the IOS-445 output module and IOS-440 input module are normally not connected together for loopback interconnection (see IOS-440/IOS-445 LOOPBACK CONNECTIONS).

#### **Grounding and Noise Considerations**

Output lines of the IOS-445 are optically isolated between the logic and field output connections. Likewise, separate port commons ensure port-to-port isolation. Consequently, the field I/O connections are isolated from the carrier board and backplane, thus minimizing the negative effects of ground bounce, impedance drops, and switching transients. However, care should be taken in designing installations to avoid inadvertently compromising isolation, or creating ground loops which can cause noise pickup and reduce overall system reliability.

# 3.0 PROGRAMMING INFORMATION

# IOS IDENTIFICATION SPACE - (Read Only, 32 Even-Byte Addresses)

Each IOS module contains identification (ID) information that resides in the ID space. This area of memory contains 32 bytes of information at most. Both fixed and variable information may be present within the ID space. Fixed information includes the "IOS" identifier, model number, and manufacturer's identification codes. Variable information includes unique information required for the module. The IOS-445 ID information does not contain any variable (e.g. unique calibration) information. ID space bytes are addressed using only the even addresses in a 64 byte block The IOS-445 ID space contents are shown in Table 3.1. Note that the baseaddress for the IOS module ID space (see the I/O Server manual) must be added to the addresses shown to properly access the ID space. Execution of an ID space read requires 0 wait states.

#### Table 3.1: IOS-445 ID Space Identification (ID) ROM

Hex Offset From ID	Numeric	
Address	(Hex)	Field Description
00	49	•
02	50	
04	41	
06	43	
08	A3	Acromag ID Code
0A	09	IOS Model Code <sup>1</sup>
0C	00	Not Used
		(Revision)
0E	00	Reserved
10	00	Not Used
12	00	Not Used
14	0C	Total Number of
		ID ROM Bytes
16	8C	CRC
18 to 3E	00	Not Used

#### Notes (Table 3.1):

- The IOS model number is represented by a two-digit code within the ID space (the IOS-445 model is represented by 09 Hex).
- 2. Execution of an ID space read requires 0 wait states.

# I/O SPACE ADDRESS MAP

This board is addressable in I/O space to control the 32 channels of digital output to the field.

The I/O space may be as large as 64, 16-bit words (128 bytes), but the IOS-445 uses only a portion of this space. The I/O space address map for the IOS-445 is shown in Table 3.2. Note that the base address for the IOS module I/O space (see your carrier board instructions) must be added to the addresses shown to properly access the I/O space. Accesses may be performed on an 8 or 16-bit basis but only D0-D7 are driven. D08-D15 are not used but will normally read high due to pull-up resistors on the carrier board.

The following table shows the memory map for the IOS-445. Data is read and written to one of four groups (ports) as designated by the address.

Table 3.2:	IOS-445 I/O Sr	bace Address (	(Hex)	Memory	v Map <sup>2</sup>

Base Addr+	MSB D15 D08	LSB D07 D00	Base Addr+
01	Not Used	Control Register	00
03	Not Used	Output Port 0 CH07 $\leftrightarrow$ CH00	02
05	Not Used	Output Port 1 CH15 $\leftrightarrow$ CH08	04
07	Not Used	Output Port 2 CH23 $\leftrightarrow$ CH16	06
09	Not Used	Output Port 3 CH31 $\leftrightarrow$ CH24	08
0B	Not	Used ⊍	0A
7F	Not	7E	

# Notes (Table 3.2):

1. The IOS will not respond to addresses that are "Not Used".

2. All Register accesses implement 0 wait state data transfers.

# **REGISTER DEFINITIONS**

#### Control Register, (Write) - (Base + 00H)

This write only register is used to reset all output ports to 0 (SSR switches OFF).

#### Table 3.3: Control Register

BIT	FUNCTION
0	1 = Software Reset
1 to 7	Not Used

#### Port Output Registers (Read/Write, 02H, 04H, 06H, and 08H)

Four registers are provided to control 32 possible output points. Data can be read from or written to one of four groups of eight output lines (Ports 0-3), as designated by the address and read/write signals. Each port assigns the least significant data line (D0) to the least significant output line of the port grouping (e.g. OD00 for port 0 to D0).

REGISTER 0 (OUTPUT SWITCHES 00 THROUGH 07):							
<u>MSB</u> 07 CH07.	06	05	04	03	02	01	<u>LSB</u> 00 CH00
REGIS	TER 1 (		SWITCHE	S 08 TH	ROUGH	15).	
<u>MSB</u> 07 CH15.	06	05	04	<del>0</del> 3	02	<u>-10).</u> 01	<u>LSB</u> 00 CH08
<u>MSB</u> 07 CH23.	06	05	04	03	02	<u>23).</u> 01	<u>LSB</u> 00 CH16
DECIS						21).	
<u>MSB</u> 07	06	05	04	03	02	<u>31).</u> 01	<u>LSB</u> 00

Write a zero to each channel's position to turn the corresponding SSR OFF. Write a one to each channel's position to turn the corresponding SSR ON.

Each output channel register can be conveniently read back for verification purposes. For critical control applications, it is recommended that outputs be directly fed back to an input point and the input point monitored (loopback I/O). Acromag Model IOS-440 32-channel isolated input modules can be used to implement loopback output monitoring with this model (see IOS-440/IOS-445 LOOPBACK CONNECTIONS).

On power-up, hardware reset, or software reset, the ports are reset to 0 forcing the outputs (SSR's) to be OFF.

# 4.0 THEORY OF OPERATION

This section contains information regarding the basic functionality of the circuitry used on the IOS-445. Refer to the IOS-445 BLOCK DIAGRAM located at the end of this manual as you review this material.

# **OUTPUT PORTS**

The field I/O interface to the carrier board is provided through connector P2 (refer to Table 2.1). Individual Solid State Relays (SSR's) for each channel isolate the field from the control logic for the IOS-445. Channels are isolated from each other in groups of eight. There are eight channels to a group or port. Because the output lines of a single port share a common connection, individual outputs are not isolated from each other within the same port. However, separate port commons are provided to facilitate port-toport isolation.

32 Single Pole Single Throw - Normally Open (SPST-NO, "1 Form A") SSR outputs are controlled by this module. Each group of eight channels can be connected directly to positive or negative supplies for high (hot) side switching. Alternatively, each group of eight channels can be connected to common for low side switching. Socketed pull-up resistors are provided for low side switching applications. These resistors should be removed if high side switching is needed. In low side switching applications the resistor values can be changed (e.g. lower values will provide a faster pull-up while a higher values will keep power dissipation from becoming a problem at higher voltages) - see Specifications in Chapter 6 for details.

The SSR's are controlled by output registers within the FPGA. Writing a '1' to the output register will turn the switch ON (closedcircuit) while writing a '0' will turn it OFF (open-circuit). Readback of the output state is accomplished by reading the output registers. However, for complete confidence in output control, loopback should be performed. This may be accomplished using the IOS-440 isolated digital input module (refer to IOS-440/IOS-445 LOOPBACK CONNECTIONS).

The SSR's employed are rated for a much higher voltage than specified. However, the field connector and printed circuit board foil spacings limit applied voltages to +/-60VDC or AC peak. Each port (group of eight channels) has a single common. Since the connectors and cables are rated to 1A maximum per pin, then each port is limited to that total current. Thus, the sum of currents . conducted by the 8 channels must stay below that total (see specifications in Chapter 6 for details). The low on resistance of the SSR's helps reduce their power dissipation when they conduct high currents; however, given the large number of channels on the board adequate air circulation must be maintained. The SSR's used in the IOS-445 are very rugged and contain built-in current limiting for their protection. They provide clean, bounce free switching and can replace electromechanical relays in many applications. SSR switching speeds are comparable to electromechanical relays (1mS. typical) but are slow compared to high speed optocouplers.

Output operation is "Fail-safe". That is, the outputs are always OFF upon power-up reset, and are automatically cleared following a software (control register) or system software reset. This is done for safety reasons to ensure reliable control of the output state under all conditions.

# 5.0 SERVICE AND REPAIR

#### SERVICE AND REPAIR ASSISTANCE

Surface-Mounted Technology (SMT) boards are generally difficult to repair. It is highly recommended that a non-functioning board be returned to Acromag for repair. The board can be damaged unless special SMT repair and service tools are used. Further, Acromag has automated test equipment that thoroughly checks the performance of each board. When a board is first produced and when any repair is made, it is tested, placed in a burn-in room at elevated temperature, and retested before shipment.

Please refer to Acromag's Service Policy Bulletin or contact Acromag for complete details on how to obtain parts and repair.

#### PRELIMINARY SERVICE PROCEDURE

Before beginning repair, be sure that all of the procedures in Section 2, Preparation For Use, have been followed. Also, refer to the documentation of your carrier board to verify that it is correctly configured. Verify that there are no blown fuses. Replacement of the carrier and/or IOS with one that is known to work correctly is a good technique to isolate a faulty board.

CAUTION: POWER MUST BE TURNED OFF BEFORE REMOVING OR INSERTING BOARDS

# WHERE TO GET HELP

If you continue to have problems, your next step should be to visit the Acromag worldwide web site at <u>http://www.acromag.com</u>. Our web site contains the most up-to-date product and software information.

Go to the "Support" tab to access:

- Application Notes
- Frequently Asked Questions (FAQ's)
- Product Knowledge Base
- Tutorials
- Software Updates/Drivers

An email question can also be submitted from within the Knowledge Base or directly from the "Contact Us" tab.

Acromag's application engineers can also be contacted directly for technical assistance via telephone or FAX through the numbers listed below. When needed, complete repair services are also available.

Phone: 248-295-0310 Fax: 248-624-9234 Email: <u>solutions@acromag.com</u>

# 6.0 SPECIFICATIONS

# **GENERAL SPECIFICATIONS**

to +125°C.
lle I/O SERVER MODULE 0 in. (102.36 mm). 0 in. (49.02 mm) 2 in. (1.59 mm) 0 in. (12.7 mm)
mA, Typical
mA, Maximum. nA, Typical
nA, Maximum.
(Not Used).
ic and field connections are cally isolated by SSR's. vidual ports are also isolated n each other. However, but lines of individual ports re a common connection and not isolated from each other. arate port commons are vided to facilitate port-to-port ation. IOS Logic and field s are isolated from each er for voltages up to 250VAC, 54V DC on a continuous is (unit will withstand a 1500V dielectric strength test for minute without breakdown). complies with test uirements outlined in SI/ISA-S82.01-1988 for the age rating specified. Port to isolation is less critical and pecified as 100V DC.
ated circuit board minimum ation spacings are as follows: -to-Logic: 24" Minimum (inner layer), 1" Minimum (external layer). -to-Port: 2" Minimum (inner layer), 0" Minimum (external layer)

# DIGITAL (SSR) OUTPUTS

Output Channel Configuration	32 isolated Solid State Relay
	(SSR) outputs supporting AC
	or DC (nigh or low side
	switching) operation.
	SPST-NO, "1 Form A" contacts.
"OFF" Voltage Range	0 to +/-60V DC or peak AC.
Output "OFF" Leakage Current	1uA Maximum (over temp.).
Output "ON" Current Range	140mA Maximum continuous
	(up to 1A total per port)
	No deration required at elevated
	ambiente
Output ON Registeres	Amblents.
Output ON Resistance	15 <u>12</u> , Maximum (25°C).
Turn-ON Time	1mS. Typical, 2mS. Maximum.
Turn-OFF Time	1mS. Typical, 2mS. Maximum.
Reset Condition	All output SSR's OFF.
Output Pull-up Resistors	Socketed 4.7K $\Omega$ (used in low
	side switching applications).
	See IOS-445 RESISTOR
	LOCATION DRAWING: Res.
	Loc. Dwg. Calculate resistor
	power for user supplied voltage
	(Power = $V^2/R$ ) Limit power to
	(1  Watt per resistor  (21  V/ max)
	@ 4.7 KO Remove or insert
	bigher value (consult fectory) for
	higher value. (consult factory) for
	nigher voltages. Install lower
	value (check power) to obtain
	faster, stronger pull-up. Remove
	for high side switching
	applications.
TTL Compatibility	Yes, used as low side switch
	can sink 27mA. @ 0.4V
	Maximum; source 500uA @ 2.4V
	Min. with 4.7K $\Omega$ pull-up to 5V
	supply.
Resistance to RFI	No digital upsets occur for field
	strengths up to 10V per meter at
	27MHz, 151MHz, & 460MHz per
	SAMA PMC 33 1 test
	procedures
Posistanco to EMI	Linit has been tested with no
	digital unsate under the influence
	of TMI from outboling coloraide
	or Eivir from switching soleholds,
	commutator motors, and drill
	motors.
ESD Protection	Output lines are protected from
	ESD voltages to $\pm$ 4KV. May
	degrade 4.7K pullups by 5%.

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IOS-445 DIGITAL OUT TØ IOS-440 DIGITAL INPUT

WHEN INTERFACING DIGITAL OUTPUT LEVELS TO THE IOS-440, USE THE MODEL IOS-440-1 (4V THRESHOLD)

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