

ARTESYN INTELLIGENT TRANSFER SWITCH

Up to 24000 Watts



PRODUCT DESCRIPTION

Designed for any application needing power switched to different loads during a 24 hour period (i.e. Horticulture, Burn-in, Test and Measurement, etc.) Advanced Energy’s Intelligent Transfer Switch has a built-in PSU to supply power to the relays and MCU module. It is designed to operate with 90 to 264 Vac standard phase input.

AT A GLANCE

Total Power

Up to 24000 Watts

Input Voltage

90 to 264 Vac Single phase

of Outputs

Up to 8

SPECIAL FEATURES

- 5 years manufacturer’s warranty
- Modular 8 channel A:B switch
- Standard 19” rack
- Reversible mounting tabs
- Designed for use with iHP and LCM4000 product families
- 100% digital control
- Intelligent zero current switching when used with Artesyn devices
- Digital communication via RS485 (Modbus-RTU)
- Cloud based user configurable GUI
- Natural convection cooled (No Fan)
- Field upgradeable firmware
- Up to 16 racks are addressable from one control node
- Configurable baud rate
- MTBF 400K hours per Telecordia SR-332 Method 1 Case 3, Part Stress
- Product lifetime 10 years minimum

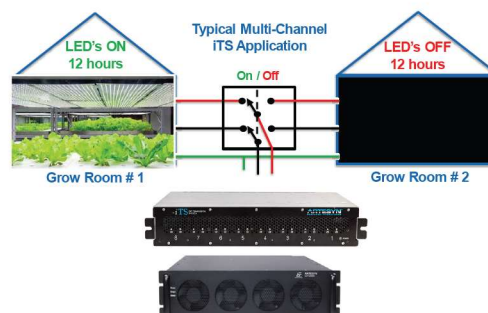
SAFETY

- EN 62368-1
- UL./CSA 62368-1
- IEC 62368-1/60601-1

TYPICAL APPLICATIONS

- Horticultura
- Industrial
- Burn-in

iTS



MODEL NUMBERS

Standard	Configuration
73-779-008	Fully configured, Rack with 8 relay modules
73-779-007	Rack with 7 relay modules
73-779-006	Rack with 6 relay modules
73-779-005	Rack with 5 relay modules
73-779-004	Rack with 4 relay modules
73-779-003	Rack with 3 relay modules
73-779-002	Rack with 2 relay modules
73-779-001	Rack with 1 relay modules
73-779-000	Relay module only
73-779-TBD	Blank relay module

Options

None

ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings

Stress in excess of those listed in the “Absolute Maximum Ratings” may cause permanent damage to the ITS. These are stress ratings only and functional operation of the unit is not implied at these or any other conditions above those given in the operational sections of this TRN. Exposure to any absolute maximum rated condition for extended periods may adversely affect the power supply’s reliability.

Table 1. Absolute Maximum Ratings						
Parameter	Model	Symbol	Min	Typ	Max	Unit
Input Voltage	All modules	$V_{IN,AC}$	90	-	264	Vac
Input Frequency	All modules		47	50/60	63	Hz
Maximum Output Power	All modules	$P_{O,max}$	-	-	24000	W
Isolation Voltage ¹						
Input to Outputs	All modules		-	-	2500	Vdc
Input to Safety Ground	All modules		-	-	2500	Vdc
Outputs to Safety Ground	All modules		-	-	2500	Vdc
Ambient Operating Temperature	All modules	T_A	0	-	50	°C
Storage Temperature	All modules	T_{STG}	-40	-	85	°C
Humidity (non-condensing)						
Operating	All modules		20	-	90	%
Storage	All modules		10	-	95	%
Altitude						
Operating	All models		-	-	9842 3000	feet meters
MTBF Telecordia SR-332, Method 1 Case3	All modules		400	-	-	Khours

Note 1 - Trip Current: 5 mA. Ramp: 500V/S. Test time: 2S.

ELECTRICAL SPECIFICATIONS

Housekeeping Power Supply Module

The transfer switch has a built-in PSU to supply power to the relays and MCU module. It is designed to operate with single phase input mains up to 264Vac nominal.

Table 2. Electrical Specifications of Power Supply Module

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Operating AC Input Voltage	All	$V_{IN,AC}$	90	-	264	Vac
Input AC Frequency	All	f_{IN}	47	50/60	67	Hz
Harmonic Line Currents	All	THD	EN 61000-3-12			
AC Input Fusing			Included for both input AC lines (not user serviceable)			
Startup Surge Current (Inrush)	$V_{IN,AC} = 264Vac$ $T_A = 25\text{ }^{\circ}C$ Cold start	$I_{IN,surge}$	-	-	50	A
Input Supply to Relay Module			12V @ 1A per module 3.3V supply as reference voltage +/- 1% 3.3V return to be connected to digital ground SGND			

ELECTRICAL SPECIFICATIONS

Relay Module

The relay is double break, capable for 25A max continuous operation. Both output lines, positive and return, are switched. To prevent arcing, the relay is only switched when zero voltage / zero current is flowing through the contacts. (Provided by master software control of the power source and Relay MCU.)

The relay module will support the following iHP voltage variants, 125Vdc, 200Vdc and 250Vdc along with the 250Vac output of LCM4000HV. iHP modules connected in series for higher voltage output is allowed, but the load maybe derated so as not to exceed the switching power rating of the relay.

Table 3. Electrical Specifications for Relay Module

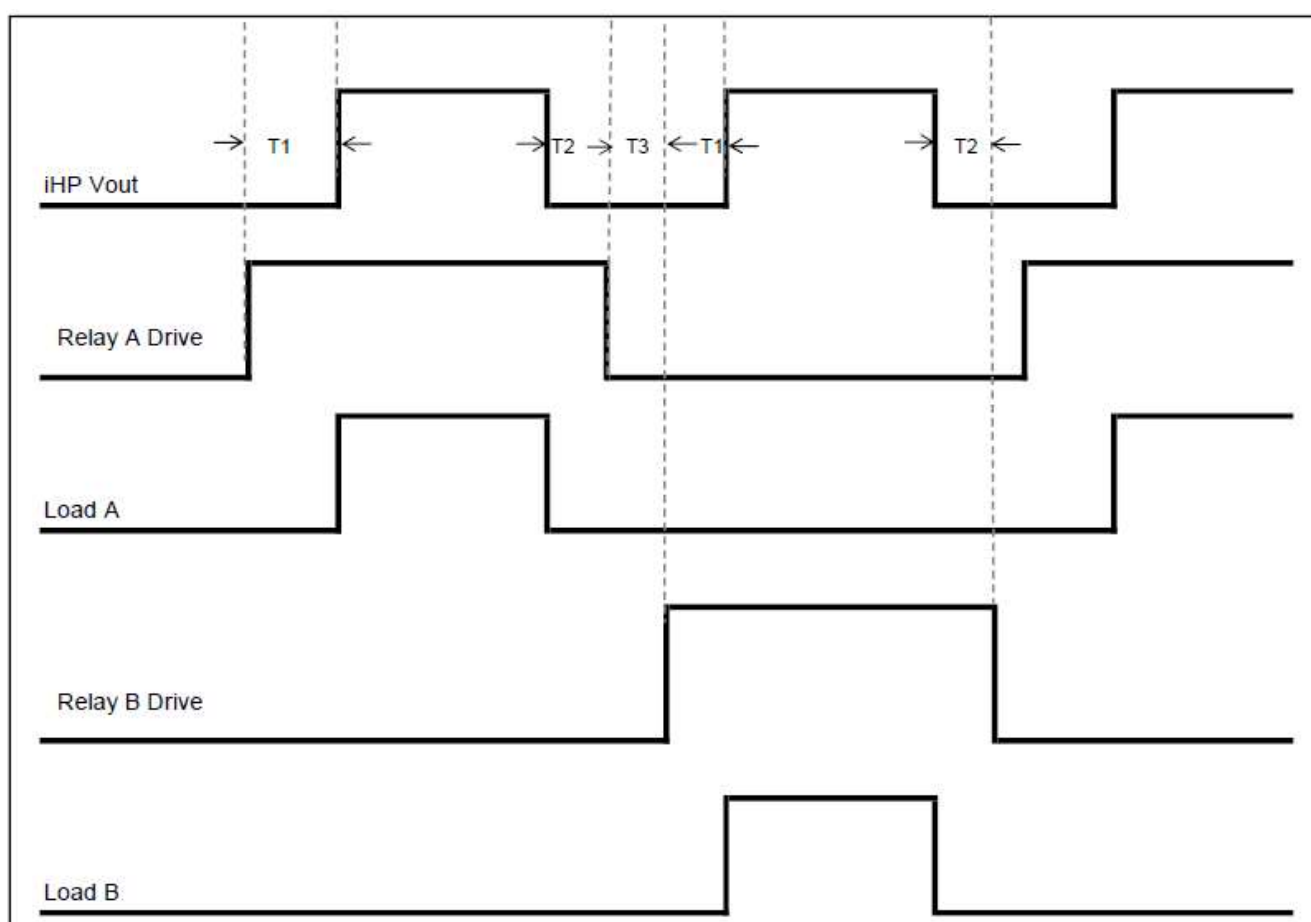
Parameter	Condition	Symbol	Min	Typ	Max	Unit
Input Number	All		One per relay module, up to 8 can be loaded in a single 2U rack			
Input Voltage Range of Relay Module	RM1 125V Module RM2 250V Module RM3 200V Module LCM4000	$V_{IN,DC}$	100 200 125 100	125 250 200 250	200 275 250 300	Vdc
Input Current for Relay Module	RM1 125V Module RM2 250V Module RM3 200V Module LCM4000	$I_{IN,max}$	- - - -	- - - -	24 12 15 16	A
Input Fault1 Level	RM1 125V Module RM2 250V Module RM3 200V Module LCM4000	$I_{IN,fault}$	28 14 18 20	- - - -	- - - -	A

Electrical Specifications

System Timing Specifications

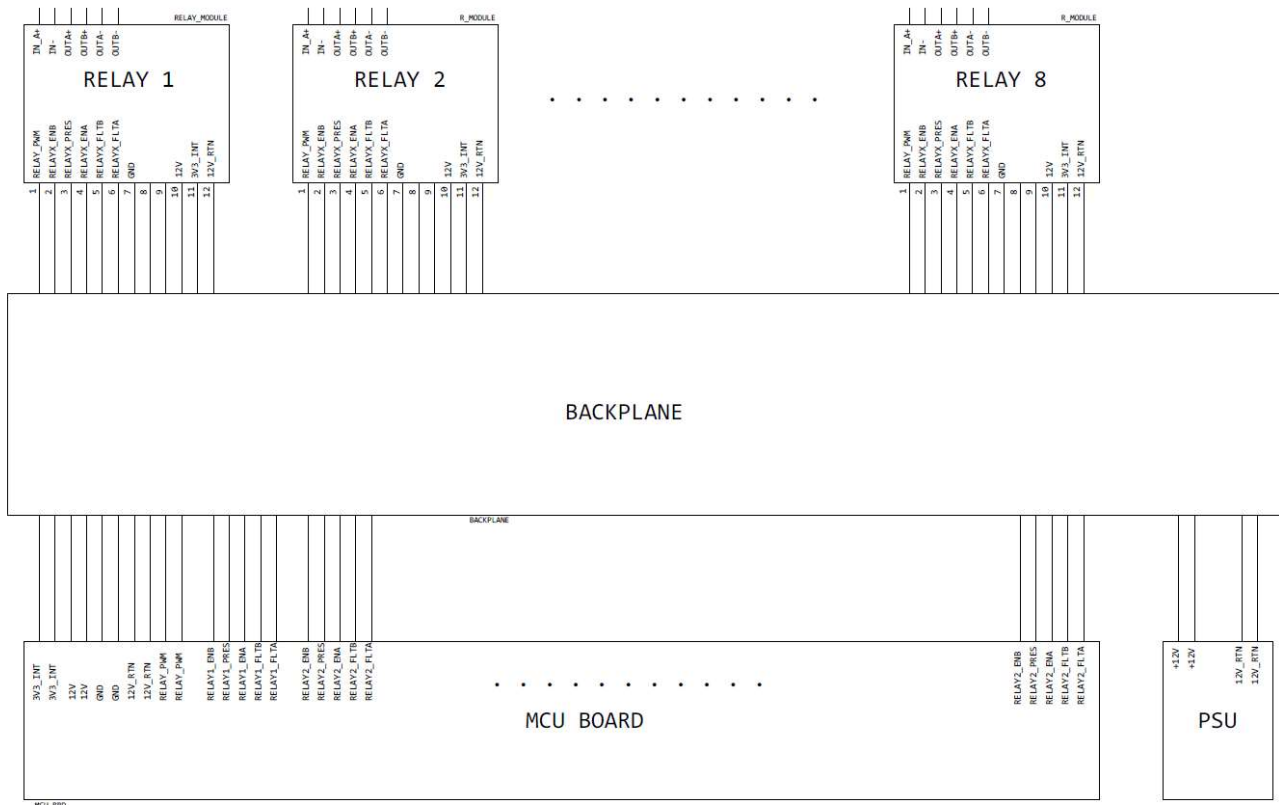
Table 4. System Timing Specifications

Label	Parameter	Min	Typ	Max	Unit
T1	Delay from driving the relay to the voltage being present at the output	100	-	-	mSec
T2	Delay from output voltage loss to the relay drive deactivation	-	-	2	Sec
T3	Delay from deactivation of relay activation of adjacent relay	-	-	2	Sec

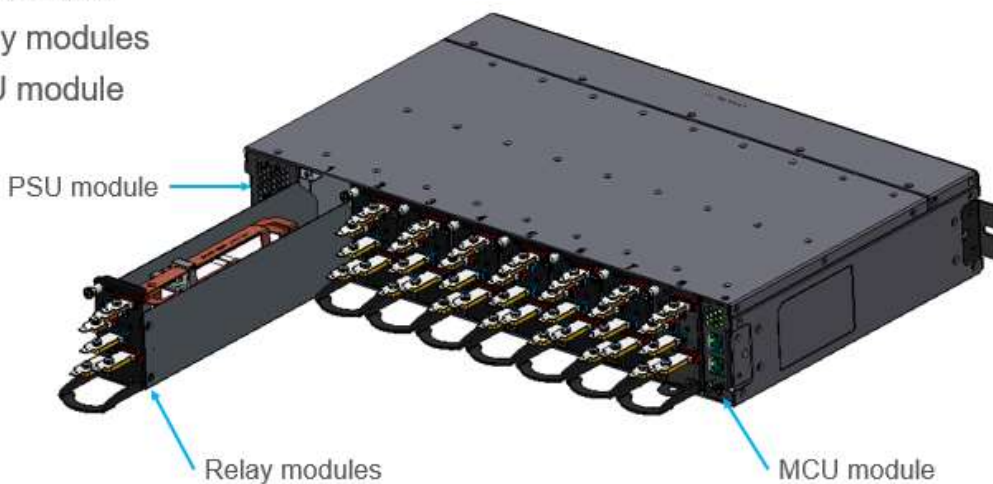


Electrical Specifications

Block Diagram



- 1 PSU module
- 8 Relay modules
- 1 MCU module



MECHANICAL SPECIFICATIONS

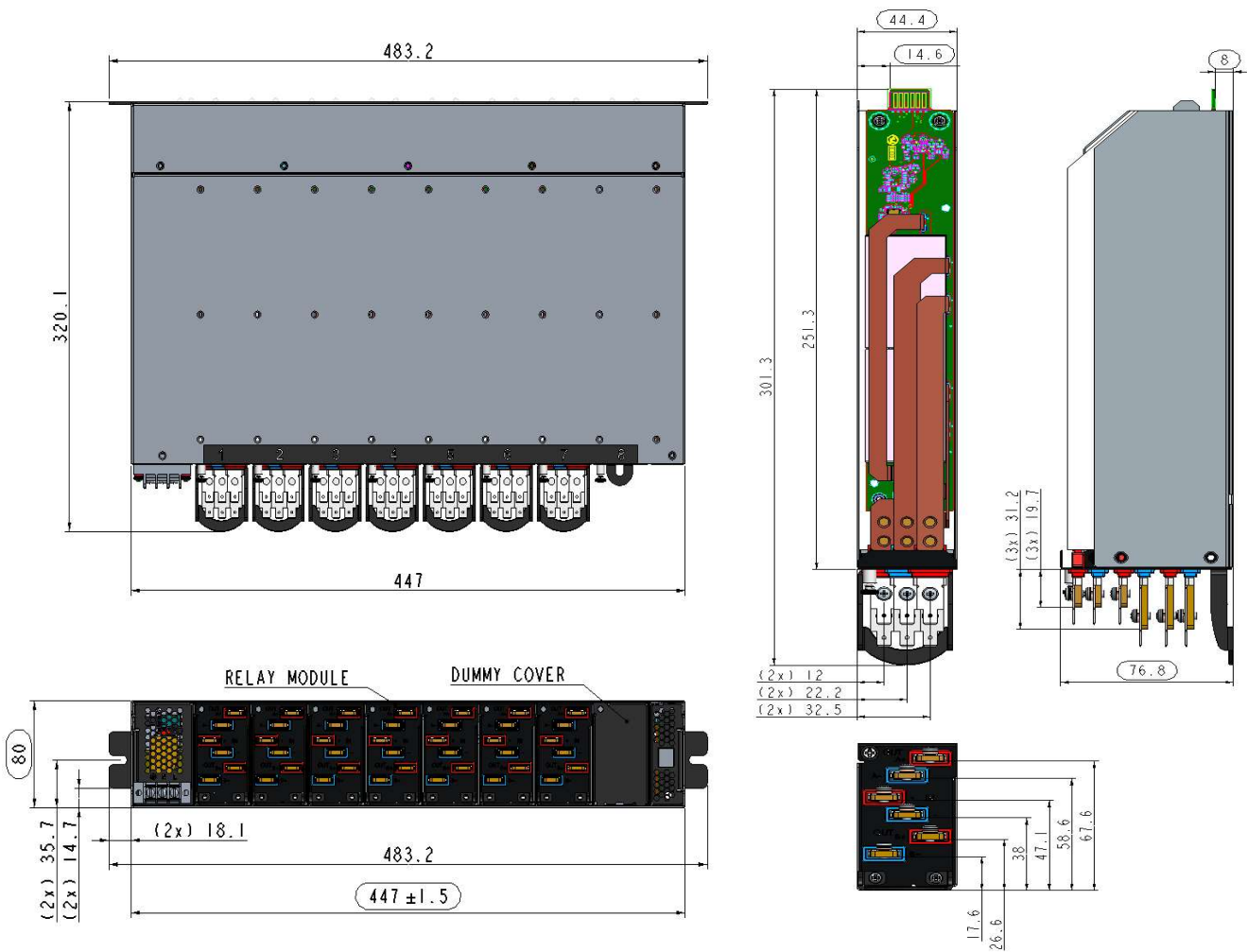
Mechanical Outlines (unit: mm)

Rack Size

Height = 81mm (2U)
 Width = 447mm
 Depth = 320.1mm

Relay module Size


Height = 76.8 mm
 Width = 44.4 mm
 Depth= 301.3 mm



MECHANICAL SPECIFICATIONS

Terminal Definitions

Input Terminal Block

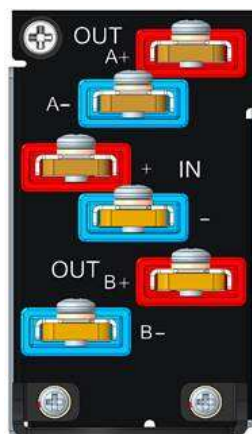
- L - Live input (1 ϕ)
- N - Neutral input (1 ϕ)
-  - Protective Earth Ground



Relay Module

Output Busbar with Faston tab Accessory

- OUT A+ - Switched Output A+
- OUT A- - Switched Output A-
- IN+ - DC Input +
- IN- - DC Input -
- OUT B+ - Switched Output B+
- OUT B- - Switched Output B-

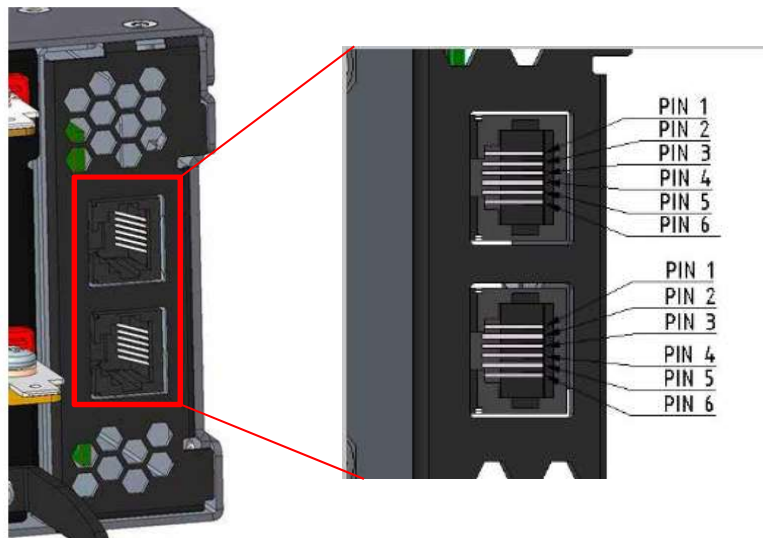


MCU Module

Communication Interface

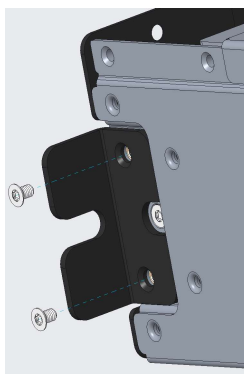
RJ11 Connector for RS485 communication

- Pin 1 - No Connection
- Pin 2 - No Connection
- Pin 3 - Ground
- Pin 4 - 5V+
- Pin 5 - A+
- Pin 6 - B-



Rack Mounting Ear

Rack mounting ears are detachable and can be placed in either the front or backside of the shelf.



ENVIRONMENTAL SPECIFICATIONS

Safety Certifications

The ITS series power supply is intended for inclusion in other equipment and the installer must ensure that it is in compliance with all the requirements of the end application. This product is only for inclusion by professional installers within other equipment and must not be operated as a stand-alone product.

Table 5. Safety Certifications for ITS Series Power Supply System		
Standard	Agency	Description
UL/CSA 62368-1	UL+CUL	US and Canada Requirements
EN 62368-1	TUV	European Requirements
IEC 62368-1	CB	International Industrial Requirements
IEC 60601-1	TUV	International Industrial Requirements
ANSI/AAMI ES60601-1	UL+CUL	

ENVIRONMENTAL SPECIFICATIONS

EMC Immunity

ITS series power supply is designed to meet the following EMC immunity specifications.

Table 6. Environmental Specifications	
Document	Description
EN55011/FCC CFR 47, Part 15, Subpart B Class A	Conducted and Radiated EMI Limits
IEC/EN61000-3-12	Harmonics ¹
IEC/EN61000-3-11	Voltage Fluctuations ¹
IEC/EN61000-4-2	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test: +/-15KV air, +/-8KV contact discharge. Performance - Criteria A
IEC/EN61000-4-3	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Radiated, radio-frequency 80M -2GHz , electromagnetic field immunity test. 10V/meter. Performance - Criteria A
IEC/EN61000-4-4	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Electrical fast transient/burst immunity test: +/-4KV for AC power port. Performance - Criteria A
IEC/EN61000-4-5	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Surge test: +/-4KV common mode and +/-2KV differential mode for AC ports. Performance - Criteria A
IEEE C62.41	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Surge test: +/-2KV common mode and +/-2KV differential mode for AC ports. Performance - Criteria A +/-6KV common mode and +/-6KV differential mode fail safe
IEC/EN61000-4-6	Conducted Immunity - 150 KHz to 80 MHz Leave/Limits 10Vrms, Performance - Criteria A
IEC/EN61000-4-8	Power Frequency Magnetic Field
EN61000-4-34	Voltage Dips, Short Interruptions and Voltage Variations

Note 1 - Applies to AC power supplies only

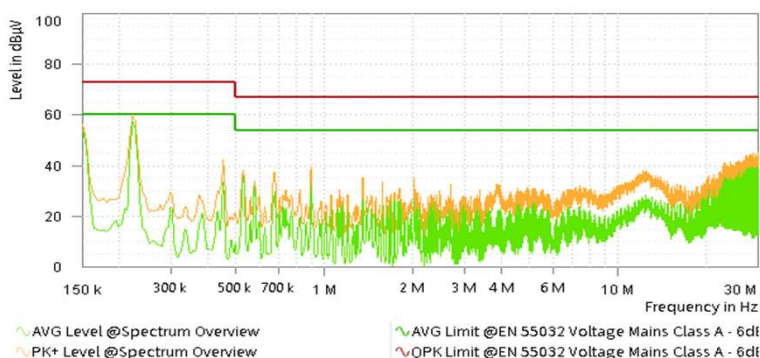
ENVIRONMENTAL SPECIFICATIONS

EMI Emissions

The ITS series has been designed to comply with the Class A limits of EMI requirements of FCC Part 15 and EN55011 for emissions and relevant sections of EN55011 for immunity. The unit is enclosed inside a metal box, tested on the DC Transfer Switch unit while assembled with a non-loaded iHP config.

Conducted Emissions

The applicable standard for conducted emissions is EN55011 (FCC Part 15). Conducted noise can appear as both differential mode and common mode noise currents. Differential mode noise is measured between the two input lines, with the major components occurring at the supply fundamental switching frequency and its harmonics. Common mode noise, a contributor to both radiated emissions and input conducted emissions, is measured between the input lines and system ground and can be broadband in nature.



The ITS series has internal EMI filters to ensure the converters' conducted EMI levels comply with EN55011 (FCC Part 15) Class A limits. The EMI measurements are performed with resistive loads at maximum rated loading.

Sample of EN55011 Conducted EMI Measurement at 200Vac Input

Note: Red Line refers to AE Quasi Peak margin, which is 6dB below the CISPR international limit. Green Line refers to the AE Average margin, which is 6dB below the CISPR international limit.

Conducted EMI emissions specifications of the ITS series:

Parameter	Model	Symbol	Min	Typ	Max	Unit
FCC Part 15, class A	All	Margin	5	-	-	dB
EN55011/CISPR11, class A	All	Margin	5	-	-	dB

ENVIRONMENTAL SPECIFICATIONS

Radiated Emissions

Unlike conducted EMI, radiated EMI performance in a system environment may differ drastically from that in a stand-alone power supply. The shielding effect provided by the system enclosure may bring the EMI level from Class A to Class B. It is thus recommended that radiated EMI be evaluated in a system environment. The applicable standard is EN55032 Class A (FCC Part 15). Testing AC-DC converters as a stand-alone component to the exact requirements of EN55032 can be difficult because the standard calls for 1m lead to be attached to the input and outputs and aligned such as to maximize the disturbance. In such a set-up, it is possible to form a perfect dipole antenna that very few AC-DC converters could pass. However, the standard also states that an attempt will be made to maximize the disturbance consistent with the typical application by varying the configuration of the test sample.

ENVIRONMENTAL SPECIFICATIONS

Storage and Shipping Temperature

The ITS series can be stored or shipped at temperatures between -40°C to +85°C and relative humidity up to 95% non-condensing.

Altitude

The ITS series will operate within specifications at altitudes up to 3000 meters above sea level.

Humidity

The ITS series will operate within specifications when subjected to a relative humidity up to 90% non-condensing. The ITS series can be stored in a relative humidity from up to 95% non-condensing.

Vibration

The ITS series pass the following vibration specifications:

Non-operating Random Vibration (Module Level)

Acceleration	1.87	gRMS	
Frequency Range	10 to 500	Hz	
Duration	30	Mins	
Direction	3 mutually perpendicular axis		
PSD Profile	FREQ (Hz)	SLOPE (db/oct)	PSD (g ² /Hz)
	10 Hz	--	0.009 g ² /Hz
	200 Hz	-2.66	0.009 g ² /Hz
	500 Hz	--	0.004 g ² /Hz

Non-operating Random Vibration (Configured Level - Shelf fully populated)

Acceleration--	1.87	gRMS	
Frequency Range	5 - 500	Hz	
Duration	30	Mins	
Direction	3 mutually perpendicular axis		
PSD Profile	10 Hz	--	0.009 g ² /Hz
	200 Hz	-2.66	0.009 g ² /Hz
	500 Hz	--	0.004 g ² /Hz

ENVIRONMENTAL SPECIFICATIONS

Operating Sine Vibration (Configured Level - Shelf fully populated)

Load	Full load ($I_{O,max} = 240A$, $I_{SB} = 3A$)	A
Line	200	Vac
Acceleration	5.0	gRMS
Frequency Range	5 to 500	Hz
Sweep Rate	1.0	Hr/sweep
Duration	1.0	Hr/axis

Shock

The ITS series pass the following vibration specifications:

Non-Operating Half-Sine Shock (Module Level)

Acceleration	30	G
Duration	11	mSec
Pulse	Half-Sine	
Number of Shock	3 shocks in each of 6 directions	

Non-Operating Half-Sine Shock (Configured Level - Shelf fully populated)

Acceleration	30	G
Duration	11	mSec
Pulse	Half-Sine	
Number of Shock	3 shocks in each of 6 directions	

Operating Shock (Configured Level - Shelf fully populated)

Load	Full load ($I_{O,max} = 240A$, $I_{SB} = 3A$)	A
Line	200	Vac
Acceleration	10	G
Duration	6	mSec
Pulse	Half-sine	
Number of Shock	3 shocks on each of 6 faces	

ENVIRONMENTAL SPECIFICATIONS


Table 7. Environmental Operating Conditions				
Parameter	Min	Typ	Max	Unit
Cooling and Audible Noise Convection Cooling	-	-	45	dB
Shipping and Handling	NSTA for <100 lbs			
Ingress Protection	IP20			
Pollution Degree	2			
RoHS Compliance	See Note Below			

Note - The Advanced Energy's Artesyn "iHP/iTS Products" meet the generally accepted RoHS 6/6 specification. Compliance with this specification includes all the components, parts, assemblies, and packaging of this product. Restricted Materials are not contained in the product or used in the manufacturing of this product or its components above the designated thresholds. The iHP Products must be in compliance of the Artesyn Technologies, Inc. RoHS, and Lead-Free 6/6 process.

POWER AND CONTROL SIGNAL DESCRIPTIONS

AC Input Pin

These terminals provide the AC mains to the ITS series.

- L – Live input (1 ϕ)
- N – Neutral input (1 ϕ)
-  – Protective Earth Ground

Output Busbar with Faston tab Accessory

These pins provide the main output for the ITS series.

- OUT A+ – Switched Output A+
- OUT A- – Switched Output A-
- IN+ – DC Input +
- IN- – DC Input –
- OUT B+ – Switched Output B+
- OUT B- – Switched Output B-

Signals

The ITS series module contains a 6 pins signal pin providing an analogue control interface.

Present - (Output)

Low asserted, to be used by MCU module to denote which slot have available relay module. To be connected ground (SGND) in relay module.

Drive_A - (Input)

High asserted, to drive relay for output A. Minimum drive strength of 8mA is required.

Drive_B - (Input)

High asserted, to drive relay for output B. Minimum drive strength of 8mA is required.

FAULT_1 (Output)

Low asserted, to trigger fault if relay coil voltage drop is >5Vdc on the active relay. And if input source is turned on and both Relay A and B are off.

FAULT_2 (Output)

Low asserted, to trigger fault if both output A and B are active (note: in the event of only relay drive active but other relay is welded/shorted). And if either output A or B is active but there is no active drive.

Note: FAULT_1 and FAULT_2 should trigger a response from MCU module to shutdown PSU output designated to the relay module with fault.

SGND (Output)

Digital ground reference of MCU module and relay module.

MODBUS SPECIFICATIONS

Device Addressing

This register set and view Intelligent Transfer Switch Device Address.

Device Address is configurable to 16 Addresses from 0xD0 to 0xDF

Register Address (0xAA) Hex	Register Address (0xAA) Decimal
0xD0*	208
0xD1	209
0xD2	210
0xD3	211
0xD4	212
0xD5	213
0xD6	214
0xD7	215
0xD8	216
0xD9	217
0xDA	218
0xDB	219
0xDC	220
0xDD	221
0xDE	222
0xDF	223

*Note: Default ITS address is 0xD0.

MODBUS SPECIFICATIONS

CRC Checking

The PSU includes an error-checking field that is based on a Cyclical Redundancy Checking (CRC) method performed on the message contents. Details are found in “Modbus over Serial Line Specification and Implementation Guide” v1.02 document section 2.5.1.2 CRC Checking.

Error Handling

The PSU will report Modbus error codes if the request command is invalid. Details are found in “Modbus over Serial Line Specification and Implementation Guide” v1.02 document section 7 MODBUS Exception Responses.

Error Code	Description
01	Illegal Function
02	Illegal Data Address
03	Illegal Data Value
04	Slave Device Failure

Operating Modes

There will be two operating modes with respect to how a system may communicate (monitor, reprogram) with the PSU: (1) MAP Mode, and (2) ISP Mode.

MAP Mode

The MAP (Main Application Program) mode is the normal operating mode of the Transfer Switch. In this mode, readable parameters are available.

ISP Mode

In ISP Mode, the firmware can be updated through the Modbus interface. MAP mode functions are inhibited in ISP mode with the exception of some Modbus commands related to the ISP operation. Only the MAP firmware will be affected by any firmware update in ISP mode. All data (except those that should change along with a firmware update, e.g. FW version) and configuration registered in the nonvolatile memory will not be altered in ISP mode.

In case of a problem during firmware update (e.g. loss of power, communication error, corrupted MAP firmware, etc.) the product will remain or boot up in ISP mode to be able to reinitiate and complete the firmware update process. After a successful firmware update the PSU will operate normally again.

MODBUS SPECIFICATIONS

ITS Support ModBus Resister

This section summarizes all Modbus Registers that are supported which can be read by either Read Holding Register (function code 03h) and can be write by Write Single Register (function code 06h).

Register Address	Data	Access Type	Data Bytes	Data Format	Description
00h	MFR ID	R	2	ASCII	Varies
02h	MFR Model	R	10	ASCII	Default: "73-779-008"
0Ch	MFR Location	R	10	ASCII	Default: "LAGUNA"
16h	MFR Date	R	4	ASCII	Default: "WW/YYYY"
1Ah	MFR Serial	R	10	-	Varies
24h	MFR FW Version	R	4	ASCII	Varies
28h to 54h	RESERVED FOR MFR SPECIFIC RELATED COMMANDS				
55h	TS Module Present Status	R	1	Bitmapped	
	b15 - Reserved				
	b14 - Reserved				
	b13 - Reserved				
	b12 - Reserved				
	b11 - Reserved				
	b10 - Reserved				
	b9 - Reserved				
	b8 - Reserved				
	b7 - MODULE 8	R			0 - No module 1 - Present
	b6 - MODULE 7				0 - No module 1 - Present
	b5 - MODULE 6				0 - No module 1 - Present
	b4 - MODULE 5				0 - No module 1 - Present
	b3 - MODULE 4				0 - No module 1 - Present
	b2 - MODULE 3				0 - No module 1 - Present
	b1 - MODULE 2				0 - No module 1 - Present
	b0 - MODULE 1				0 - No module 1 - Present

MODBUS SPECIFICATIONS

ITS Series Supported Modbus Register List:

Register Address	Data	Access Type	Data Bytes	Data Format	Description
56h	TS Command Status	R	1	Bitmapped	
	b15 - Reserved				
	b14 - Reserved				
	b13 - Reserved				
	b12 - Reserved				
	b11 - Reserved				
	b10 - Reserved				
	b9 - Reserved				
	b8 - Reserved				
	b7 - MODULE 8 STATUS	R			0 – No Error 1 – Error
	b6 - MODULE 7 STATUS				0 – No Error 1 – Error
	b5 - MODULE 6 STATUS				0 – No Error 1 – Error
	b4 - MODULE 5 STATUS				0 – No Error 1 – Error
	b3 - MODULE 4 STATUS				0 – No Error 1 – Error
	b2 - MODULE 3 STATUS				0 – No Error 1 – Error
	b1 - MODULE 2 STATUS				0 – No Error 1 – Error
b0 - MODULE 1 STATUS				0 – No Error 1 – Error	
57h	Fault Status ¹	R	1	Bitmapped	
	b15 - Reserved				
	b14 - Reserved				
	b13 - Reserved				
	b12 - Reserved				
	b11 - Reserved				
	b10 - Reserved				
	b9 - Reserved				
	b8 - Reserved				
	b7 - MODULE 8 FAULT2				
	b6 - MODULE 7 FAULT1				
	b5 - MODULE 6 FAULT2				0 – No Fault, 1 – Fault
	b4 - MODULE 5 FAULT2				0 – No Fault, 1 – Fault
	b3 - MODULE 4 FAULT2				0 – No Fault, 1 – Fault
	b2 - MODULE 3 FAULT2				0 – No Fault, 1 – Fault
	b1 - MODULE 2 FAULT2				0 – No Fault, 1 – Fault
b0 - MODULE 1 FAULT2				0 – No Fault, 1 – Fault	

Note 1 : Fault Status Register Bits [0:7] asserts if:

1. Input Source is turned on and both Relays A and B are off. 2. Input source is turned on and either Relay A or B has high Impedance. 3. More than 5V voltage drop between output voltage and input source voltage.

Fault Status Register Bits [8:15] asserts if:

1. Input source is turned on and either or both of Relay A and B are welded. 2. And if either output A or B has output but there is no active drive.

MODBUS SPECIFICATIONS

ITS Series Supported Modbus Register List:

Register Address	Data	Access Type	Data Bytes	Data Format	Description
58h	TS Module 1 Status	R	1	Bitmapped	
	b15 - FAULT COUNTER				
	b14 - FAULT COUNTER				
	b13 - FAULT COUNTER				
	b12 - FAULT COUNTER				
	b11 - FAULT COUNTER				
	b10 - FAULT COUNTER				
	b9 - FAULT COUNTER				
	b8 - FAULT COUNTER				
	b7 - RESERVED				
	b6 - RESERVED				
	b5 - RESERVED				
	b4 -				
	b3 - MODULE [X] CONTROL STATUS				00 – Disable Relay A and B 01 – Enable Relay A and Disable Relay B 10 – Disable Relay A and Enable Relay B 11 – Invalid
b2 - FAULT_2				0 – No Fault, 1 – Fault	
b1 - FAULT_1				0 – No Fault, 1 – Fault	
b0 - PRESENT				0 – No Module 1 – Module Present	
59h	TS Module 2 Status	R	1	Bitmapped	Same as 58h
5Ah	TS Module 2 Status			Bitmapped	Same as 58h
5Bh	TS Module 2 Status			Bitmapped	Same as 58h
5Ch	TS Module 2 Status			Bitmapped	Same as 58h
5Dh	TS Module 2 Status			Bitmapped	Same as 58h
5Eh	TS Module 2 Status			Bitmapped	Same as 58h
5Fh	TS Module 2 Status			Bitmapped	Same as 58h

MODBUS SPECIFICATIONS

ITS Series Supported Modbus Register List:

Register Address	Data	Access Type	Data Bytes	Data Format	Description
60h	Fault Counter Limit	R	1	Bitmapped	
	b15 - Reserved				
	b14 - Reserved				
	b13 - Reserved				
	b12 - Reserved				
	b11 - Reserved				
	b10 - Reserved				
	b9 - Reserved				
	b8 - Reserved				
	b7 - MODULE 8				
	b6 - MODULE 7				
	b5 - MODULE 6				0 – Good Condition 1 – Replacement is needed
	b4 - MODULE 5				0 – Good Condition 1 – Replacement is needed
	b3 - MODULE 4				0 – Good Condition 1 – Replacement is needed
	b2 - MODULE 3				0 – Good Condition 1 – Replacement is needed
	b1 - MODULE 2				0 – Good Condition 1 – Replacement is needed
b0 - MODULE 1				0 – Good Condition 1 – Replacement is needed	
61h	Maintenance Status	R	1	Bitmapped	
	b15 - Reserved				
	b14 - Reserved				
	b13 - Reserved				
	b12 - Reserved				
	b11 - Reserved				
	b10 - Reserved				
	b9 - Reserved				
	b8 - Reserved				
	b7 - MODULE 8				
	b6 - MODULE 7				
	b5 - MODULE 6				0 – Good Condition 1 – Replacement is needed
	b4 - MODULE 5				0 – Good Condition 1 – Replacement is needed
	b3 - MODULE 4				0 – Good Condition 1 – Replacement is needed
	b2 - MODULE 3				0 – Good Condition 1 – Replacement is needed
	b1 - MODULE 2				0 – Good Condition 1 – Replacement is needed
b0 - MODULE 1				0 – Good Condition 1 – Replacement is needed	

Note: Maintenance Status Register Bits [0:7] asserts if the corresponding module fault counter is beyond the Fault Counter Limit Register value

MODBUS SPECIFICATIONS

ITS Series Supported Modbus Register List:

Register Address	Data	Access Type	Data Bytes	Data Format	Description										
AAh	ITS Device Address	R/W	1	Bitmapped											
ABh	Baud Rate Config	R/W			<table border="1"> <thead> <tr> <th>Value (Hex)</th> <th>Baud Rate Config</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>9600</td> </tr> <tr> <td>1</td> <td>19200</td> </tr> <tr> <td>2</td> <td>38400</td> </tr> <tr> <td>3</td> <td>115200 (Default)</td> </tr> </tbody> </table>	Value (Hex)	Baud Rate Config	0	9600	1	19200	2	38400	3	115200 (Default)
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	b7: b6 - MODULE 4 CONTROL				00 – Disable Relay A and B 01 – Enable Relay A and Disable Relay B 10 – Disable Relay A and Enable Relay B 11 – Invalid										
	b5: b4 - MODULE 3 CONTROL				00 – Disable Relay A and B 01 – Enable Relay A and Disable Relay B 10 – Disable Relay A and Enable Relay B 11 – Invalid										
	b3: b2- MODULE 2 CONTROL				00 – Disable Relay A and B 01 – Enable Relay A and Disable Relay B 10 – Disable Relay A and Enable Relay B 11 – Invalid										
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MODBUS SPECIFICATIONS

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MODBUS SPECIFICATIONS

ModBus Read Holding Registers

Request

Description	Byte Count	Additional Information
Function Code	1 Bytes	0x03
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 125 (0x7D)
CRC	2 Bytes	

Response

Description	Byte Count	Additional Information
Function Code	1 Bytes	0x03
Byte Count	1 Bytes	2*N
Register Value	N*2 Bytes	
CRC	2 Bytes	

Error

Description	Byte Count	Additional Information
Error Code	1 Bytes	0x83
Exception Code	1 Bytes	01 or 02 or 03 or 04

MODBUS SPECIFICATIONS

ModBus Write Holding Registers

Request

Description	Byte Count	Additional Information
Function Code	1 Byte	0x06
Register Address	2 Bytes	0x0000 to 0xFFFF
Register Value	2 Bytes	0x0000 to 0xFFFF
CRC	2 Bytes	

Response

Description	Byte Count	Additional Information
Function Code	1 Byte	0x06
Register Address	1 Bytes	0x0000 to 0xFFFF
Register Value	N*2 Bytes	0x0000 to 0xFFFF
CRC	2 Bytes	

Error

Description	Byte Count	Additional Information
Error Code	1 Byte	0x86
Exception Code	1 Byte	01 or 02 or 03 or 04

IN-SYSTEM FIRMWARE UPDATE

This section describes the different commands involved in the in-system programming (firmware update) and the process in performing the update.

ISP Related Commands

ISP_CTRL_CMD

The ISP_CTRL_CMD command (user-defined function code 42h) is used to control In-System Programming (ISP) operations depending on the operating mode of the PSU. This is a write command.

Data/Command Byte	Internal Command	Description	Applicability
00	00	- Exit ISP mode - Attempt to boot the main application program	PSU in ISP mode
01	01	- Enter ISP mode - Enable all commands required to perform an in-system firmware update	PSU in MAP mode
01	02	- Restart programming sequence - Reset the address counter to the start address	PSU in ISP mode

ISP_FLASH_DATA

Request

Description	Byte Count	Description
Function Code	1 Bytes	0x42
Byte Count	1 Bytes	0x01 to 0x42
Block No	2 Bytes	0x00 to 0x31F
Data Value	64 Bytes	
CRC	2 Bytes	

Response

Description	Byte Count	Description
Function Code	1 Bytes	0x42
Byte Count	1 Bytes	0x01 to 0x42
Block No	2 Bytes	0x00 to 0x31F
Data Value	1 Byte	00 or 01 or 02 or 03 or 04
CRC	2 Bytes	

IN-SYSTEM FIRMWARE UPDATE

Error

Description	Byte Count	Description
Error Code	1 Bytes	0xC2
Exception Code	1 Bytes	01 or 02 or 03 or 04

Parsing the Firmware Image

The firmware is in Hex format. Since only the data words of the Hex are needed in the update process, the record must be parsed to remove the other parts that are not needed (e.g. record type, byte count, address, checksum). In a Hex file, all records with record type 00 will be used. These are called Data records. Other record types are discarded. All data sequence records starting from address 6000h until FFFFh in the Hex file must be parsed and sent to the PSU continuously in 64-byte groups. The addressing mode used is 16-bit mode.

Suppose a random line on the Hex file:1060000038260008F8C3590F79300800000000C0.

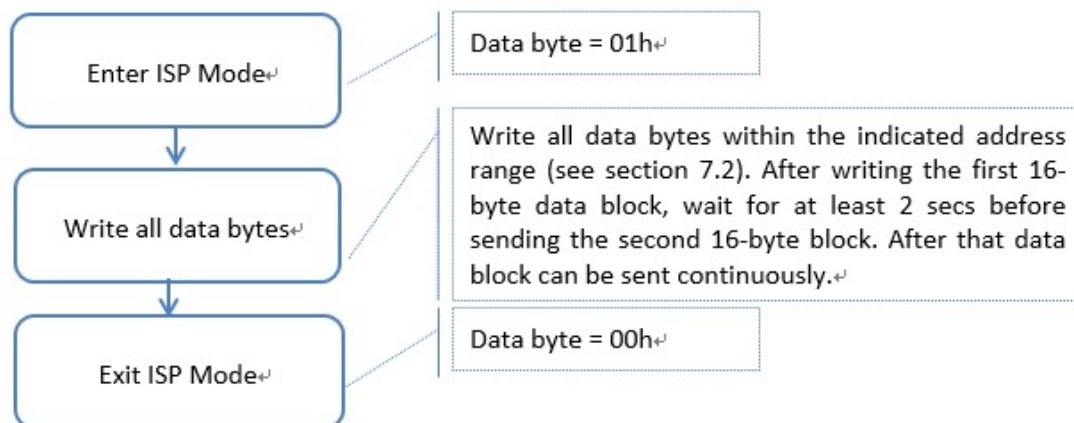
Record Type	Byte Count	Address	Data Words	Checksum
00	10	6000	38260008F8C3590F79300 0800000000	C0

Address Data Words:

6000	3826
6001	0000
6002	8F8C
6003	3590
6004	F793
6005	0008
6006	0000
6007	0000

IN-SYSTEM FIRMWARE UPDATE

Firmware Update Process



In any case that the firmware update process fails (e.g. due to loss of power, communication error, etc.) the PSU will stay in ISP mode. The process may be reinitiated. After successful programming the PSU will start up normally again.

RECORD OF REVISION AND CHANGES

Issue	Date	Description	Originators
1.0	08.18.2021	First Issue	K. Wang
1.1	04.21.2022	Update picture	K. Wang



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