Integrated Monitoring and Control System

iMAC2 Controller EtherNet/IP (CIP) Communications Manual

Version: 4 – Oct 2018

Designed and Manufactured in Australia by Ampcontrol Pty Ltd

WARNING!

The **warning** symbol highlights a potential risk of **injury or death**.

Please share these warnings with other operators.

CAUTION!

The **caution** symbol highlights a potential risk of **damage to equipment**.

Please share these cautions with other operators.

NOTE

The **note** symbol highlights **key information**.

Please share these notes with other operators.

ENVIRO

The **enviro** (environmental) symbol highlights areas which may have an impact on the surrounding **fauna and/or flora**.

Copyright Notice

Disclaimer

While every effort has been made to assure the accuracy and clarity of this document, AMPCONTROL PTY LTD assumes no liability resulting from any omissions in this document, or from misuse of the information obtained herein. The information in this document has been carefully checked and is believed to be entirely reliable with all of the necessary information included. AMPCONTROL PTY LTD reserves the right to make changes to any products described herein to improve reliability, function, or design, and reserves the right to revise this document and make changes from time to time in content hereof with no obligation to notify any persons of revisions or changes. AMPCONTROL PTY LTD does not assume any liability arising out of the application or any use of any product or circuit described herein; neither does it convey license under its patent rights or the rights of others.

Before You Begin

Thank you for purchasing the Ampcontrol iMAC2 System.

WARNING!

In the interests of **safety and correct equipment operation**, please take the time to read and understand the content in this manual.

Ampcontrol Contact Details

7 Billbrooke Close, Cameron Park, NSW, 2285

P +61 1300 267 373 | F +61 2 4903 4888

EMAIL: customerservice@ampcontrolgroup.com

WEB: ampcontrolgroup.com

TABLE OF CONTENTS

TABLE OF FIGURES

1 DOCUMENT SCOPE

1.1 Document Scope

This document is intended to provide a detailed explanation of the communications protocols supported by the iMAC2 Controller's Ethernet port.

This document is not intended to provide information on the operation of the overall iMAC System, individual modules or instruction on programming the iMAC2 Controller or modules. Please refer to the relevant supplementary documents for this information.

1.2 Supplementary Documents

The iMAC2 Controller Ethernet/IP Communications Manual is intended to be read in conjunction with the following documents:

1.2.1 System Documentation

- IMAC2B010 iMAC2 Controller Modbus TCP-IP Communications Manual
- IMAC2B009 iMAC2 System User Manual
- IMAC2B011 iMAC2 Controller Web Interface Manual
- IMACB094 iMAC System Installation Requirements
- IMACB182 iMAC SIL Emergency Stop Qualification
- IMACB005 iMAC Module Programming Manual

1.2.2 Module Documentation

- IMACB003 iMAC RO4 Module Technical Datasheet
- IMACB018 iMAC LPU Module Technical Datasheet
- IMACB020 iMAC DI8 Module Technical Datasheet
- IMACB045 iMAC IIM Module Technical Datasheet
- IMACB046 iMAC DI4 Module Technical Datasheet
- IMACB047 iMAC EOL/MEOL Module Technical Datasheet
- IMACB060 iMAC LED4 Module Technical Datasheet
- IMACB061 iMAC SSW Module Technical Datasheet
- IMACB062 iMAC SQM Module Technical Datasheet
- IMACB066 iMAC AIM Module Technical Datasheet
- IMACB067 iMAC RTD1 Module Technical Datasheet
- IMACB141 iMAC ARM Module Technical Datasheet
- IMACB142 iMAC CRM Module Technical Datasheet
- IMACB143 iMAC EMM Module Technical Datasheet
- IMACB144 iMAC GRM Module Technical Datasheet
- IMACB146 iMAC IRK Keypad Technical Datasheet
- IMACB147 iMAC PIM Module Technical Datasheet
- IMACB148 iMAC SIM-G Module Technical Datasheet
- IMACB149 iMAC SIM-G2 Module Technical Datasheet
- IMACB150 iMAC SIM-T Module Technical Datasheet
- IMACB151 iMAC MLB Barrier Technical Datasheet
- IMACB152 iMAC SLB Barrier Technical Datasheet
- IMACB154 iMAC SIM-P Module Technical Datasheet

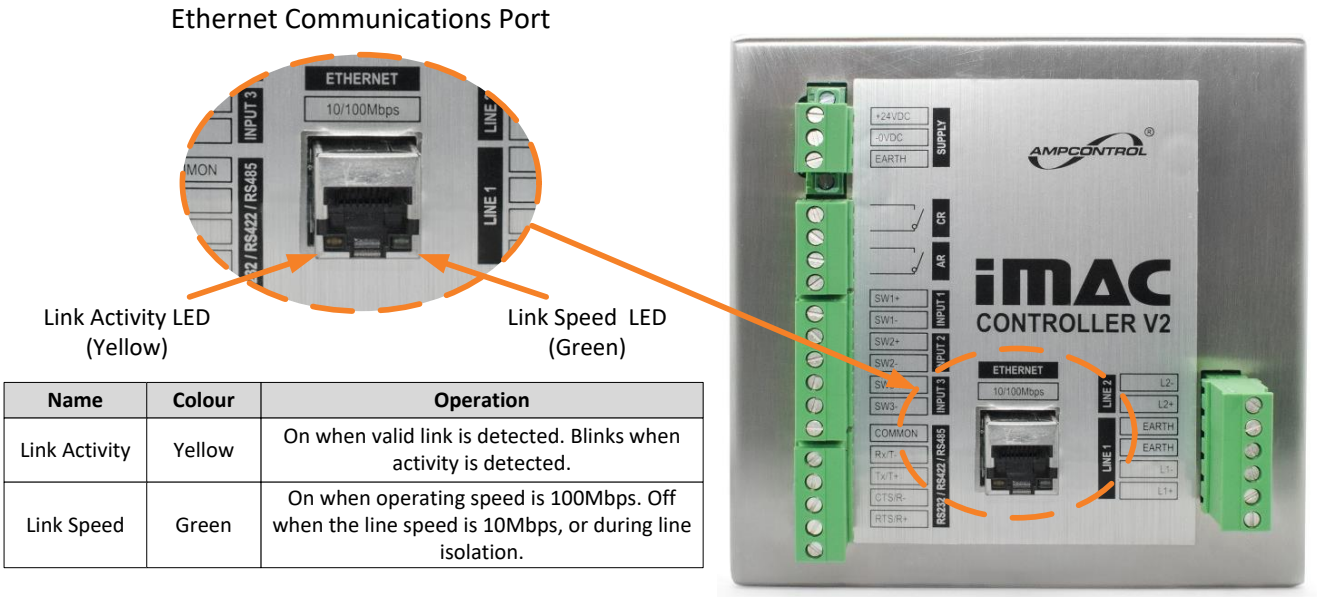
2 iMAC2 CONTROLLER ETHERNET/IP COMMUNICATIONS OVERVIEW

The iMAC2 Controller is equipped with an Ethernet port and a serial communication port. This manual details the use of the Ethernet port. For information pertaining to the use of the serial communications port, refer to the IMACB153 iMAC Controller Serial Communications Manual.

NOTE

The **Ethernet port is a read only communications port**. The iMAC2 Controller has been manufactured in this way to maintain the SIL "Proven in Use" statistics of the previous iMAC Controller.

2.1 Specifications



Name	Colour	Operation
Link Activity	Yellow	On when valid link is detected. Blinks when activity is detected.
Link Speed	Green	On when operating speed is 100Mbps. Off when the line speed is 10Mbps, or during line isolation.

Figure 1: Location of the Ethernet Communications Port

Table 1: Ethernet Communications Port Specifications

Ethernet TCP/IP Port	
Available Interfaces	RJ45 10/100MB, Auto Negotiation
Applicable Standards	IEEE 802.3u, IEEE 802.3x
Cable Requirements	10BASE-T: UTP category 3, 4, 5 cable (maximum 100m) 100BASE-TX: UTP category 5, 5e cable (maximum 100m) EIA/TIA-568 100Ω STP (maximum 100m)
Supported Protocols	EtherNet/IP (Port 2222, Unicast), NTP (for time synchronisation), Webserver (for configuration, data viewing and diagnostic functions)
Maximum Request Rate	400ms
Recommended Response Timeout	200ms
Maximum Concurrent Web Connections	The iMAC2 Controller allows four users to access the web server.

2.2 Connecting to the Ethernet Port for the First Time

The iMAC2 Controller's factory default Ethernet IPv4 settings are as follows:

Table 2: Default Ethernet Communications Port Settings

Default Ethernet IPv4 Settings	
IP Address	10.1.1.10
Subnet Mask	255.255.255.0

If the Controller's IPv4 settings have been changed, they can be restored to the factory default settings by pressing the iMAC2 Controller's Ethernet Reset button for 4 seconds (The internal iMAC2 Controller status LED will turn on solid while the reset button is depressed, after 4 seconds the LED will change to a fast flash to indicate settings have been reset to default, after which the button can then be released).

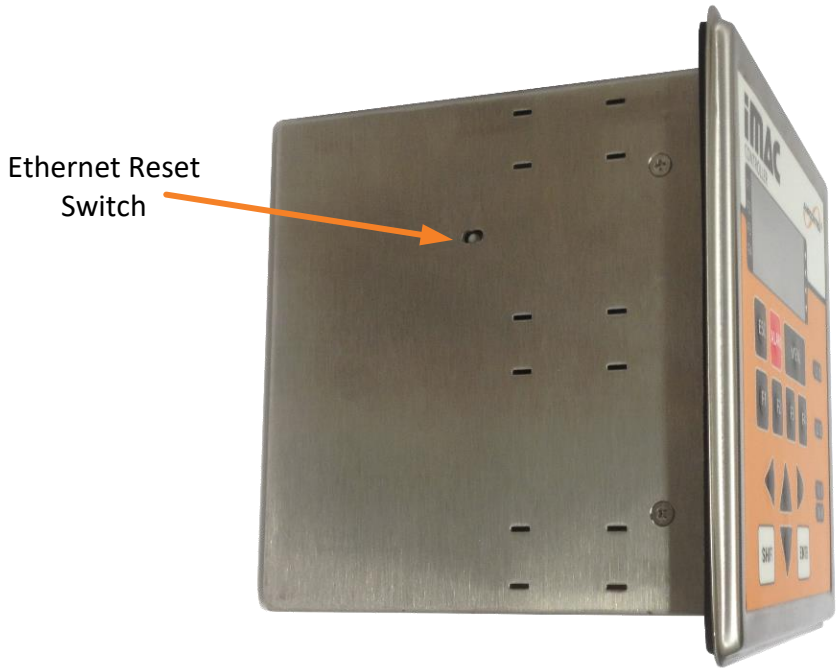


Figure 2: Location of Ethernet Reset Switch

The iMAC2 Controller's Ethernet port settings are not configurable via the HMI; they must be altered using the iMAC2 Web Interface. The Controller's web server can be accessed using a one-to-one Ethernet connection with an Ethernet enabled device.

Temporarily configure your device's Ethernet port as follows:

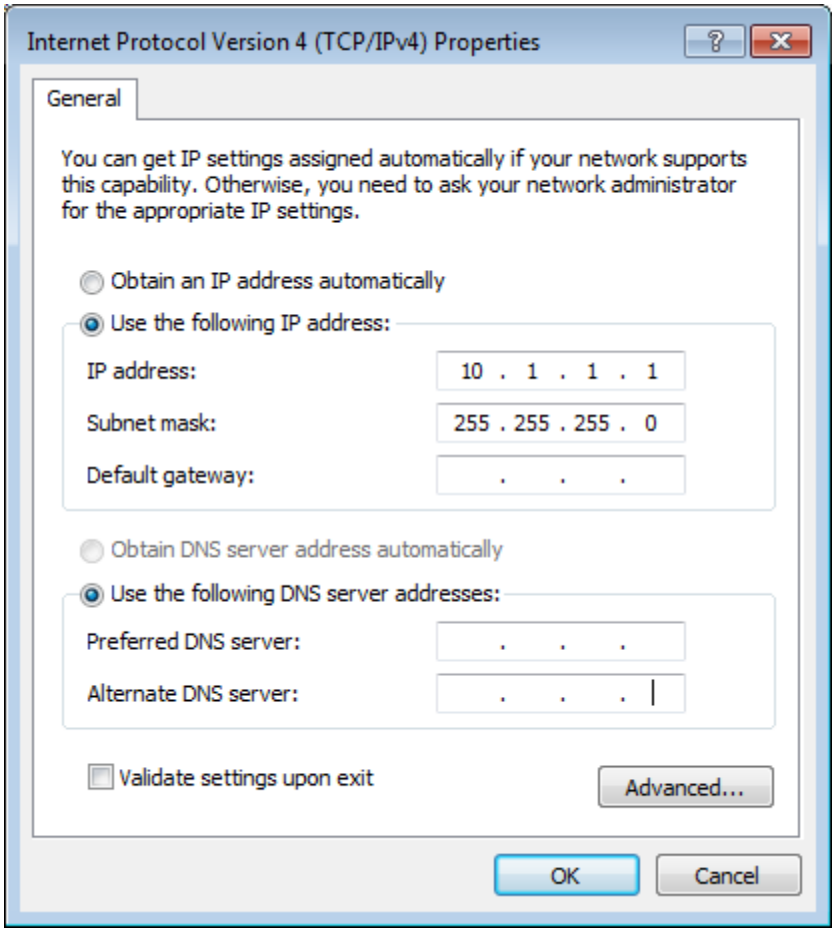


Figure 3: Updating the Ethernet Port Settings of the Connectable Device

Once the network adaptor of the external device has been configured as shown in Figure 3, connect the iMAC2 Controller's Ethernet port directly to your device's Ethernet port, the iMAC2 Controller should then be able to be pinged at 10.1.1.10. Once a successful ping has been performed, open a web browser (Chrome recommended) and enter the iMAC2 Controller's IP address into the address bar: http://10.1.1.10; the iMAC2 Controller web pages should load within a few seconds.

Navigate to the Ethernet Settings page to configure the IP settings for the iMAC2 Controller:

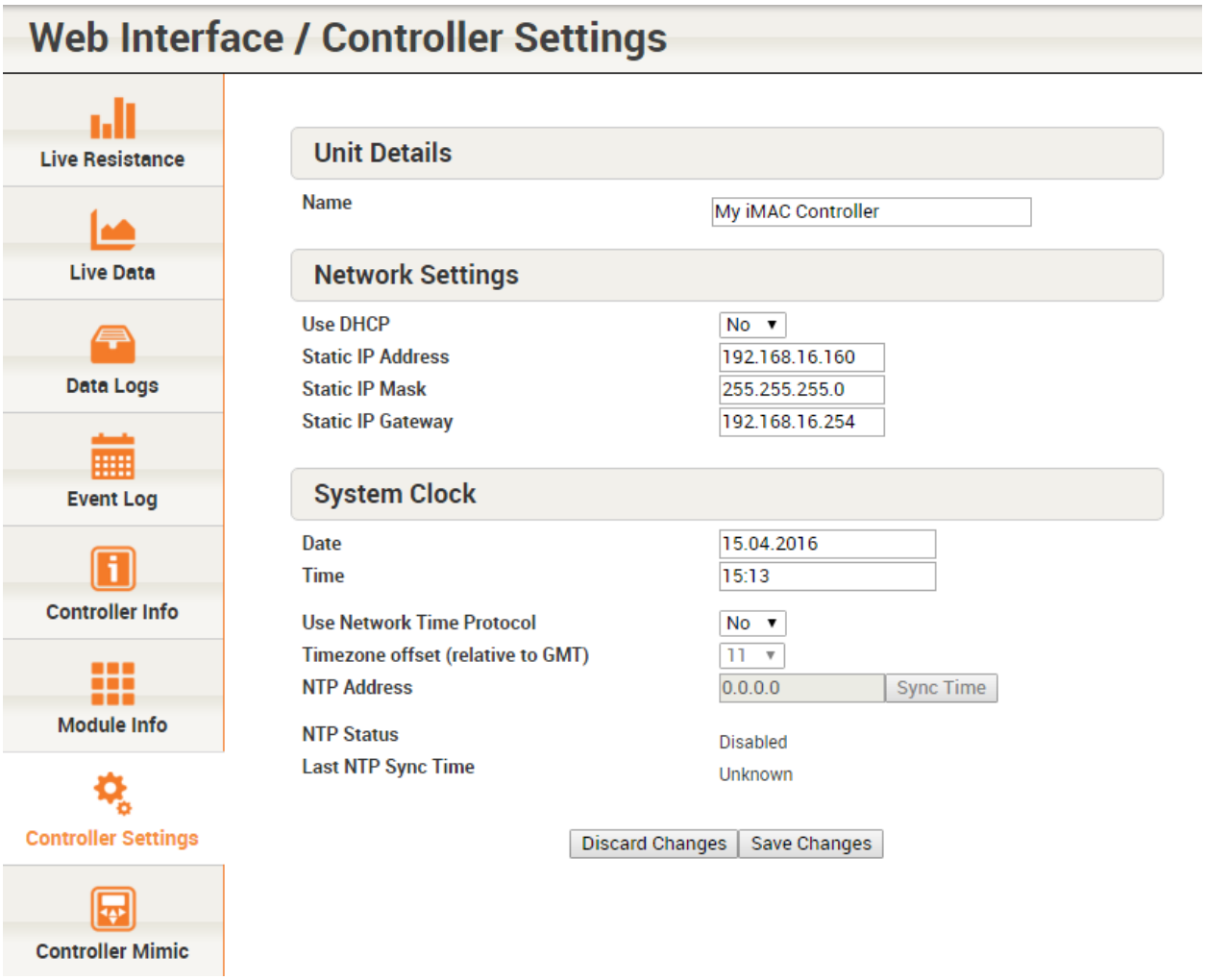


Figure 4: Updating the iMAC2 Controller Ethernet Port Settings

For information on this process, refer to the IMAC2B011 iMAC2 Controller Web Interface Manual.

2.3 EtherNet/IP Protocol

The iMAC2 Controller uses industry standard EtherNet/IP protocol for exchanging data with compatible Ethernet devices. The EtherNet/IP protocol is the adaptation of the Common Industrial Protocol to the Ethernet platform. EtherNet/IP allows both implicit (synchronous) and Explicit (asynchronous) messaging, with UDP port 2222 being used for implicit messages.

The iMAC2 data transfer is carried out via the following Assembly Instances:

- Input Assembly Instance 100: defined by a block of 100 (16-bit) words.
- Output Assembly Instance 150: defined by a block of 30 (16-bit) words. (Not currently used).
- Config Assembly Instance 50: defined by a block of 0 bytes. (Not currently used).

The requested packet interval is configurable, and to guarantee all iMAC module data is sent to the PLC this interval needs to be set to a rate faster than the iMAC controller is scanning its connected modules (referred to as the iMAC Controller's "linespeed"). The linespeed is set by the iMAC SLP code, and can be configured in the range from 300 to 1000.

There are three commonly used linespeeds: 300, 500 and 1000. The following table specifies the maximum EIP "packet interval time" that can be used for each of the commonly used linespeeds.

Table 3: Maximum EIP Packet Interval

iMAC Linespeed	EIP Packet Interval (max)
1000	100 ms
500	225 ms
300	400 ms

The requested packet interval defaults to 225msec, with a maximum allowed being 400msec.

NOTE

The iMAC2 Controller does not support multicast connections, only unicast connections are supported so PLC device settings such as "Use Unicast Connection over EtherNet/IP" must be enabled.

3 THE iMAC2 CONTROLLER'S DATA TRANSFER

The data transferred over EtherNet/IP is a progressive transfer of the iMAC2 data contained within the iMAC2 Data Point Table. Each implicit message transfer updates the input assembly instance as follows:

3.1 Input Assembly Instance Layout

Table 4: iMAC2 Controller Input Assembly Instance Data Structure

Word Offset	Description
0	Start Block Address
1	Module 1 Data
2	Module 1 Status
3	Module 1 Resistance
4	Module 1 ErrCnt
5	Module 2 Data
6	Module 2 Status
7	Module 2 Resistance
8	Module 2 ErrCnt
9	Module 3 Data
10	Module 3 Status
11	Module 3 Resistance
12	Module 3 ErrCnt
13	Module 4 Data
14	Module 4 Status
15	Module 4 Resistance
16	Module 4 ErrCnt
17	Unused
18	Unused
19	Unused

20	System Status (Modbus 0x100)
21	System Control (Modbus 0x400)
22	System ID and Control (Modbus 0x401)
23	L1 Data Block Just Complete (Modbus 0x406)
24	Main Loop Timer Counter(SLP) (Modbus 0x408)
25	Module Rollcall Control (Modbus 0x409)
26	Rollcall Address (Modbus 0x40A)
27	Rollcall Serial Number (Modbus 0x40B)
28	Rollcall Type Register (Modbus 0x40C)
29	Rollcall Block Number (Modbus 0x40D)
30	Rollcall Parameter 1 (Modbus 0x40E)
31	Rollcall Parameter 2 (Modbus 0x40F)
32	Rollcall Parameter 3 (Modbus 0x410)
33	Rollcall Parameter 4 (Modbus 0x411)
34	Mimic Key Press (Modbus 0x60F)
35	SLP Fault Register (Modbus 0x50C)
36	SLP Fault Address (Modbus 0x50D)
37	Controller Hardware Flags (Modbus 0x600)
38	Controller Temperature (Modbus 0x601)
39	EOL Series Resistance (Modbus 0x200)
40	EOL Shunt Resistance (Modbus 0x300)
41	EOL Offline Count (Modbus 0x415)
42	EOL Clash Count (Modbus 0x416)
43	EOL Serial Number (Modbus 0x404)
44	MEOL Status (Modbus 0x0160)

45	MEOL Series Resistance (Modbus 0x260)
46	MEOL Offline / Clash Count (Modbus 0x360)
47	MEOL serial number (Modbus 0x060)
48	Unused
49	Unused
50 to 73	General Buffer Registers (24 of these) (Modbus 0x0480 to 0x0498)
74	Unused
75 to 98	Non Volatile Memory (24 registers) (Modbus 0x0520 to 0x0538)
99	Unused

Therefore, module data for four modules is sent from the iMAC2 at each packet time (offset 1 to 16), as well as controller data (offset 20 to 37), EOL/MEOL module data (offset 38 to 47), General Buffer data (offset 50 to 73) and Non-Volatile Memory data (offset 75 to 98). The Start Block Address at offset 0 specifies the node address of the first of four modules in each transfer. This Start Block Address is incremented by 4 for each implicit message transfer. So that data for nodes 0, 1, 2 and 3 is updated at packet time *t*, then data for nodes 4, 5, 6 and 7 is updated at packet time *t+1*, and so on until data for nodes 252, 253, 254 and 255 is sent (at packet time *t+63*). Then the Start Block Address is reset to 0, and data for nodes 0, 1, 2 and 3 is updated again.

Applications requiring iMAC2 data over EtherNet/IP need to take this progressive data update into account. (This is taken care of in the RSLogix5000 Add-On Instruction described later).

3.2 Module Types

The table below provides the module types that are associated with the possible values of the “Rollcall Type”. This is reproduced from the document “IMAC2B010 iMAC2 Controller Ethernet Communications Manual”.

Table 5: Module type designations.

Module Type Table Corresponding Values for Rollcall Type Register (Address 1036, 40Ch)					
Value		Module Type	Value		Module Type
Decimal	Hexadecimal		Decimal	Hexadecimal	
0	0000h	Reserved	32	0020h	LED4 Module
1	0001h	Controller	33	0021h	EMM Module
2	0002h	TCD2 DIPSwitch	34	0022h	Undefined #34
3	0003h	EOL Module	35	0023h	SIM-P Module
4	0004h	SQM Module	36	0024h	SIM-T Module
5	0005h	DI2/4 Module	37	0025h	SIM-G Module
6	0006h	IIM-OLC Module	38	0026h	DI5 Module
7	0007h	LIM Module	39	0027h	RO4 Module
8	0008h	TCD4 Long	40	0028h	TO4 Module
9	0009h	TCD4 Module	41	0029h	GCA Flags
10	000Ah	RTD3 Flags	42	002Ah	GCA 15Min Tally
11	000Bh	RTD3 Temp 1	43	002Bh	GCA 8Hr Tally
12	000Ch	RTD3 Temp 2	44	002Ch	GCA 24Hr Tally
13	000Dh	RTD3 Temp 3	45	002Dh	GCA Raw Count
14	000Eh	DI4L Module	46	002Eh	DI8 Module
15	000Fh	DI4 Module	47	002Fh	RIS Module
16	0010h	IIM Module	48	0030h	AIM Flags
17	0011h	PGM-A Programr	49	0031h	AIM Analog
18	0012h	MEOL Module	50	0032h	AIM PwrSupply
19	0013h	Undefined #19	51	0033h	CRM Module
20	0014h	SSW Flags	52	0034h	ARM Module
21	0015h	SSW Control	53	0035h	GRM Module
22	0016h	SSW % Slip	54	0036h	RTD1 Flags
23	0017h	SSW % Speed	55	0037h	RTD1 Temp
24	0018h	SSW Linr Speed	56	0038h	SIM-G2 Module
25	0019h	Undefined #25	57	0039h	FCP DigInputs
26	001Ah	Undefined #26	58	003Ah	FCP DigOutputs
27	001Bh	GAI3 Flags	59	003Bh	FCP AnaInputs
28	001Ch	GAI3 Analogue #1	60	003Ch	FCP AnaOutputs
29	001Dh	GAI3 Analogue #2	61	003Dh	GG2 Flags
30	001Eh	GAI3 Analogue #3	62	003Eh	GG2 Analog
31	001Fh	RKM Keypad	63	003Fh	GG2 PwrSupply

4 DATA HANDLING – RSLogix5000 APPLICATIONS

A set of RSLogix5000 user-defined data types (UDTs) and add-on instructions (AOIs) have been constructed to retrieve iMAC2 data over the new EtherNet/IP connection, for connection to ControlLogix PLCs. These components will be described here.

4.1 UDTs

There are module-specific UDTs, as well as generic UDTs used by the module-specific UDTs. These will all be described in a logical order.

4.1.1 iMac_SystemStatus_DT

This UDT stores the iMAC2 Controller Runtime System Status bits. It is used by iMac_Ctrl_Runtime_DT. It has the following members.

Member Name	Data Type	Description
RefreshCycle	BOOL	Set by the controller at the end of every refresh cycle (refresh cycle = all 255 module addresses have been scanned). May be cleared by writing a 0 into this bit using application (SLP) software.
L1ChksErr	BOOL	Set by the controller when a checksum error is detected on L1 fieldbus. May be cleared by writing a 0 into this bit using application (SLP) software.
L1Ok	BOOL	Set by the controller when a L1 fieldbus scan completes with no errors detected. May be cleared by writing a 0 into this bit using application (SLP) software.
L2ChksErr	BOOL	Set by the controller when a checksum error is detected on L2 fieldbus. May be cleared by writing a 0 into this bit using application (SLP) software.
L2Active	BOOL	Set by controller when it detects an active fieldbus from another controller on its L2 port. Often used to condition the operation of the L2 LED on the controller.
CtrlRelayState	BOOL	Status of the Control Relay. 1 = Energised. 0 = De-energised.
AuxRelayState	BOOL	Status of the Auxiliary Relay. 1 = Energised. 0 = De-energised.
EOL_OK	BOOL	Set by controller when EOL module is being detected on the L1 fieldbus with no faults, clear otherwise.
EOL_SC	BOOL	Set by controller when the L1 fieldbus is short circuited (R<1000Ω), clear otherwise
EOL_OC	BOOL	Set by controller when EOL module is not detected on the L1 fieldbus and the fieldbus is not short circuited, clear otherwise.
EOL_CLASH	BOOL	Set by controller when two EOL modules are detected on the L1 fieldbus, clear otherwise.

UART_Rx	BOOL	Set by controller when its serial port is receiving data
UART_Tx	BOOL	Set by controller when its serial port is transmitting data

4.1.2 iMac_SystemControl_DT

This UDT stores the iMAC2 Controller Runtime System Control bits. It is used by iMac_Ctrl_Runtime_DT. It has the following members.

Member Name	Data Type	Description
StartUp	BOOL	Set by controller on first SLP loop following power up
Always1	BOOL	This bit is always set to 1
SeqDownFromL2	BOOL	Sequence Down Bit from Upstream iMAC Controller
SeqUpFromL1	BOOL	Sequence Up Bit from Downstream iMAC Controller/SQM module
SwInput1	BOOL	iMAC Controller SW1 status: 1 = closed, 0 = open.
SwInput2	BOOL	iMAC Controller SW2 status: 1 = closed, 0 = open.
SwInput3	BOOL	iMAC Controller SW3 status: 1 = closed, 0 = open.
AsrtCtrlRelay	BOOL	Set by application (SLP) software to attempt to energise the CR relay. CR will energise if and only if EOL Module comms is also healthy. Clear to de-energise CR relay.
AsrtAuxRelay	BOOL	Set by application (SLP) software to energise AR relay. Clear to de-energise AR relay.
SeqUpOnL2	BOOL	Upstream sequence control bit
SeqDownOnL1	BOOL	Downstream sequence control bit
EnFlashWrite	BOOL	Enables data to be written to the iMAC Controller's flash memory using Modbus write commands
FullSysMenu	BOOL	The following menu functions are disabled when FullSysMenu = 0 & enabled when FullSysMenu = 1 - System Menu 'CLR DPT' item, Maintenance page F1 - Clear individual OnScan Bit
MinSysMenu	BOOL	The following menu functions are disabled when MinSysMenu = 0 & enabled when MinSysMenu = 1 - System Menu (SHIFT+MENU), Debug Menu, Maintenance page F4 – Clear individual OFFLINE/CLASH COUNTERS

DisableWriteCmds	BOOL	Prevents Modbus Master devices writing to iMAC Controller Modbus registers

4.1.3 iMac_Ctrl_Runtime_DT

This UDT stores the iMAC2 Controller Runtime data. It is used by iMac_Controller_DT. It has the following members.

Member Name	Data Type	Description
SystemStatus	iMac_SystemStatus_DT	System Status
SystemControl	iMac_SystemControl_DT	System Control
SysIdLeds	INT	System ID and LED control
L1BlockJustDone	INT	L1 Data Block Just Complete
LoopTimeSLP	INT	Main Loop Timer Counter (SLP)
RollcallControl	INT	Module Rollcall Control
RollcallAddress	INT	Rollcall Address
RollcallSerNum	INT	Rollcall Serial Number
RollcallModType	INT	Rollcall Type Register
RollcallBlckNum	INT	Rollcall Block Number
RollcallParam1	INT	Rollcall Parameter 1
RollcallParam2	INT	Rollcall Parameter 2
RollcallParam3	INT	Rollcall Parameter 3
RollcallParam4	INT	Rollcall Parameter 4
MimicKeyPress	INT	Mimic Key Press
SLPFaultRegister	INT	SLP Fault Register
SLPFaultAddress	INT	SLP Fault Address
HardwareFlags	INT	Controller Hardware Flags
ControllerTemp	INT	Controller Temperature
EOL_Status	INT	EOL Status

EOL_Series_Resistance	INT	EOL Series Resistance
EOL_Shunt_Resistance	INT	EOL Shunt Resistance
EOLS_OC	INT	EOL Offline Count
EOLS_Clash	INT	EOL Clash Count
EOL_SerNum	INT	EOL Serial Number
MEOL_Status	INT	MEOL Status
MEOL_Series_Resistance	INT	MEOL Series Resistance
MEOLS_Offline_Clash_Count	INT	MEOL Offline + Clash Count
MEOL_SerNum	INT	MEOL Serial Number

4.1.4 iMac_Ctrl_LCD_DT

This UDT stores the iMAC2 Controller LCD data. It is included in the iMac_Controller_DT, but is not currently used. It has the following members.

Member Name	Data Type	Description
LCD_String_Data_Row1	INT[10]	LCD String Data Row 1
LCD_String_Data_Row2	INT[10]	LCD String Data Row 2
LCD_String_Data_Row3	INT[10]	LCD String Data Row 3
LCD_String_Data_Row4	INT[10]	LCD String Data Row 4
LCD_Cursor_Location	INT	LCD Cursor Location

4.1.5 iMac_Controller_DT

This UDT stores the iMAC2 Controller data, including the data for all possible 256 modules in an iMAC network. It is a stand-alone data type. It has the following members.

Member Name	Data Type	Description
DATA	INT[256]	Controller Data.
STATUS	INT[256]	Controller Status.
RESIST	INT[256]	Controller Resistance entries.
ERROR	INT[256]	Controller Errors.
Runtime	iMac_Ctrl_Runtime_DT	Run-time data.
LCD	iMac_Ctrl_LCD_DT	LCD-related data.
GENBUFF	INT[24]	General Buffer registers (area 480).
NVM	INT[24]	User NVM registers (area 520).

Note that the LCD data is not currently retrieved from the iMAC2 over EtherNet/IP, and so the LCD member is empty.

4.1.6 iMac_Network_Config_Entry_DT

This UDT defines the iMAC2 network configuration Lookup table entry data. It is used by iMac_Network_Config_DT. It has the following members.

Member Name	Data Type	Description
Module_Type	DINT	Network types are listed in the document 'IMAC2B010 iMAC2 Controller Ethernet Communications Manual'
Module_Type_Data1	DINT	Type Data1 is: For SIM_G, SIM-G2, SIM-P and SIM-T modules: references the SIM-G, SIM-G2, SIM-P and SIM-T unit; for all other modules, this member is currently not used.
Module_Type_Data2	DINT	Type Data2 is: For SIM_G, SIM-G2, SIM-P and SIM-T modules: this member references the register index; for all other modules, this member is currently not used.

Note that the Module_Type member has type numbers that follow the numbering defined in the iMAC2 system, and reproduced in *Table 5: Module type designations.*

4.1.7 iMac_Network_Config_DT

This UDT stores the iMAC2 network configuration information (the lookup table). It has one member as follows.

Member Name	Data Type	Description
Lookup_Table	iMac_Network_Config_Entry_DT[256]	The configuration of up to 256 iMAC modules in a network attached to an iMAC controller; each module is identified by the module type.

4.1.8 iMac_STATUS_DT

This UDT stores the iMAC Status Bit information. It is used by all module UDTs to be described hereafter. It has the following members.

Member Name	Data Type	Description
OnScanBit	BOOL	Set by the controller when it first detects an input module address online on its L1 fieldbus. May be cleared by application (SLP) software. (POR=0)
L1ClashBit	BOOL	Set by the controller when two input modules transmit different data on the same address, clear otherwise.
Global	BOOL	Must be intentionally set by application (SLP) software if the corresponding data address needs to be published up the L2 fieldbus, thus making it a Global Address.
L1OwnBit	BOOL	Set by the controller when it detects an input module address on its L1 fieldbus, cleared if module not detected.
L2OwnBit	BOOL	Set by the controller when it detects the corresponding address on its L2 fieldbus. The Global Select bit for this address must be set to allow the controller to “see” up its L2 fieldbus. This should be done during the STARTUP segment of the application (SLP) software.
SysOwnBit	BOOL	Must be intentionally set application (SLP) software when the corresponding data register is to be owned by the system. Setting this bit forces the corresponding data register to be an output. All addresses are assumed to be an input unless this bit is set. If an input module is connected to a system owned address on L1, a L1 clash error will occur.
L2ClashBit	BOOL	Set by the controller when it detects the address is Online on both its L1 and L2 ports if the address Global Select bit is set.
HighByteBit	BOOL	Must be intentionally set by application (SLP) software when the corresponding data register is to be partially owned by the system. Low byte of data register remains as input, but SLP can now write into high byte for output functions.

GenPurpose0	BOOL	General purpose use in application (SLP) software.
GenPurpose1	BOOL	General purpose use in application (SLP) software.
GenPurpose2	BOOL	General purpose use in application (SLP) software.
GenPurpose3	BOOL	General purpose use in application (SLP) software.
GenPurpose4	BOOL	General purpose use in application (SLP) software.
GenPurpose5	BOOL	General purpose use in application (SLP) software.
GenPurpose6	BOOL	General purpose use in application (SLP) software.
GenPurpose7	BOOL	General purpose use in application (SLP) software.

4.1.9 iMac_ERROR_DT

This UDT stores the iMAC module Error information. It is used by most of the module UDTs to be described hereafter. It has the following members.

Member Name	Data Type	Description
Module_Offline_Count	INT	This count is incremented every data scan that there is no owner of the module address for which there was once an owner.
Module_Clash_Count	INT	This count is incremented every time that a data scan occurs when L1 Clash = 1 (i.e. increments each time an address is scanned for which there are two modules with the same address that are transmitting different input data).

4.1.10 iMac_AIM_AI_ModDT

This UDT stores the iMAC AIM Analog Input Module Data Type information (Note – all UDTs for iMAC modules have names ending with *_ModDT*, to distinguish them from other generic UDTs defined here). It has the following members.

Member Name	Data Type	Description
AIM_Analogue_Input	INT	Module Analogue Input
AIM_Analogue_Status	iMac_STATUS_DT	Module Status
AIM_Analogue_Resist	INT	Module Resistance Value
AIM_Analogue_Errors	iMac_ERROR_DT	Module Error Counters

Note that all module-related UDTs have the specific Data members, plus status bits, resistance value and error counts (although the LED4 and RO4 modules don't have resistance or error members, and the IIM Module has an extra IIM_LEDs member).

4.1.11 iMac_AIM_FLAGS_ModDT

This UDT stores the iMAC AIM Analog Flags Module Data Type information. It has the following members.

Member Name	Data Type	Description
AIM_FLAGS_Bit0_AI_LT_SP3	BOOL	Module Flags - Analogue input < Set point 1
AIM_FLAGS_Bit1_AI_GE_SP2	BOOL	Module Flags - Analogue input >= Set point 2
AIM_FLAGS_Bit2_AI_GE_SP3	BOOL	Module Flags - Analogue input >= Set point 3
AIM_FLAGS_Bit3_AI_betw_1_2	BOOL	Module Flags - Set point 1 ≤ Analogue input < Set point 2
AIM_FLAGS_Bit4_AI_betw_2_3	BOOL	Module Flags - Set point 2 ≤ Analogue input < Set point 3
AIM_FLAGS_Bit5_PS_LT_SPA	BOOL	Module Flags - Power Supply < SP A (warn)
AIM_FLAGS_Bit6_PS_LT_SPB	BOOL	Module Flags - Power Supply < SP B (trip)
AIM_FLAGS_Status	iMac_STATUS_DT	Module Status
AIM_FLAGS_Resist	INT	Module Resistance Value
AIM_FLAGS_Errors	iMac_ERROR_DT	Module Error Counters

4.1.12 iMac_AIM_Power_ModDT

This UDT stores the iMAC AIM Power Supply Module data. It has the following members.

Member Name	Data Type	Description
AIM_Power_Supply	INT	Module Power Supply Data
AIM_Power_Supply_Status	iMac_STATUS_DT	Module Status
AIM_Power_Supply_Resist	INT	Module Resistance Value
AIM_Power_Supply_Errors	iMac_ERROR_DT	Module Error Counters

4.1.13 iMac_DI4_ModDT

This UDT stores the iMAC DI4 Module data. It has the following members.

Member Name	Data Type	Description
DI4_Inputs_IP1	BOOL	Module Input IP1
DI4_Inputs_IP2	BOOL	Module Input IP2
DI4_Inputs_IP3	BOOL	Module Input IP3
DI4_Inputs_IP4	BOOL	Module Input IP4
DI4_Inputs_Applic_Dept	SINT	Module Input Data High Byte - Application Dependent
DI4_Status	iMac_STATUS_DT	Module Status
DI4_Resist	INT	Module Resistance Value
DI4_Errors	iMac_ERROR_DT	Module Error Counters

4.1.14 iMac_DI8_ModDT

This UDT stores the iMAC DI8 Module data. It has the following members.

Member Name	Data Type	Description
DI8_Inputs_IP1	BOOL	Module Input IP1
DI8_Inputs_IP2	BOOL	Module Input IP2
DI8_Inputs_IP3	BOOL	Module Input IP3
DI8_Inputs_IP4	BOOL	Module Input IP4
DI8_Inputs_IP5	BOOL	Module Input IP5
DI8_Inputs_IP6	BOOL	Module Input IP6
DI8_Inputs_IP7	BOOL	Module Input IP7
DI8_Inputs_IP8	BOOL	Module Input IP8
DI8_Inputs_Applic_Dept	SINT	Module Input Data High Byte - Application Dependent
DI8_Status	iMac_STATUS_DT	Module Status
DI8_Resist	INT	Module Resistance Value
DI8_Errors	iMac_ERROR_DT	Module Error Counters

4.1.15 iMac_GAI3_FLAGS_ModDT

This UDT stores the iMAC GAI3 Module Status data. It has the following members.

Member Name	Data Type	Description
GAI3_FLAGS_Bit0_AI1_ALM	BOOL	Module Flags - Analogue input 1 Alarm Bit (1=Alarm; 0=No Alarm).
GAI3_FLAGS_Bit1_AI2_ALM	BOOL	Module Flags - Analogue input 2 Alarm Bit (1=Alarm; 0=No Alarm).
GAI3_FLAGS_Bit2_AI3_ALM	BOOL	Module Flags - Analogue input 3 Alarm Bit (1=Alarm; 0=No Alarm).
GAI3_FLAGS_Bit3_ADC_Fail	BOOL	Module Flags - GAI3 Internal Fault (ADC Fail) (1=Fault; 0=No Fault).
GAI3_FLAGS_Bit8_AI1_OL_Status	BOOL	Module Flags - AI Module 1 Online Status (1=Online; 0=Offline).
GAI3_FLAGS_Bit9_AI2_OL_Status	BOOL	Module Flags - AI Module 2 Online Status (1=Online; 0=Offline).
GAI3_FLAGS_Bit10_AI3_OL_Status	BOOL	Module Flags - AI Module 3 Online Status (1=Online; 0=Offline).
GAI3_FLAGS_Status	iMac_STATUS_DT	Module Status
GAI3_FLAGS_Resist	INT	Module Resistance Value
GAI3_FLAGS_Errors	iMac_ERROR_DT	Module Error Counters

4.1.16 iMac_GAI3_AI_ModDT

This UDT stores the iMAC GAI3 Module Analogue data. It is used for the three analogue values associated with the GAI3 module. It has the following members.

Member Name	Data Type	Description
GAI3_Analogue_Input	INT	Module Analogue Input
GAI3_Analogue_Status	iMac_STATUS_DT	Module Status
GAI3_Analogue_Resist	INT	Module Resistance Value
GAI3_Analogue_Errors	iMac_ERROR_DT	Module Error Counters

4.1.17 iMac_IIM_ModDT

This UDT stores the iMAC IIM Module data. It has the following members.

Member Name	Data Type	Description
IIM_Inputs_IP1	BOOL	Module Input IP1
IIM_Inputs_IP2	BOOL	Module Input IP2
IIM_Inputs_IP3	BOOL	Module Input IP3
IIM_Inputs_IP4	BOOL	Module Input IP4
IIM_Inputs_IP5	BOOL	Module Input IP5
IIM_Inputs_Bit5_ALine_Monitor_IP	BOOL	Module Input Data - A-line Monitor IP
IIM_Inputs_Bit7_RandomBit	BOOL	Module Input Data - Random Bit
IIM_Inputs_Applic_Dept	SINT	Module Input Data High Byte - Application Dependent
IIM_Status	iMac_STATUS_DT	Module Status
IIM_Resist	INT	Module Resistance Value
IIM_Errors	iMac_ERROR_DT	Module Error Counters
IIM_LEDs	INT	LED Output Data

4.1.18 iMac_LED4_ModDT

This UDT stores the iMAC LED4 Module data. It has the following members.

Member Name	Data Type	Description
LED4_Outputs_LED1	BOOL	Module Output LEDs - LED1
LED4_Outputs_LED2	BOOL	Module Output LEDs - LED2
LED4_Outputs_LED3	BOOL	Module Output LEDs - LED3
LED4_Outputs_LED4	BOOL	Module Output LEDs - LED4
LED4_Status	iMac_STATUS_DT	Module Status

4.1.19 iMac_RIS_ModDT

This UDT stores the iMAC RIS Module data. It has the following members.

Member Name	Data Type	Description
RIS_Inputs_IP1	BOOL	Module Input IP1
RIS_Inputs_IP2	BOOL	Module Input IP2
RIS_Inputs_IP3	BOOL	Module Input IP3
RIS_Inputs_IP4	BOOL	Module Input IP4
RIS_Inputs_IP5	BOOL	Module Input IP5
RIS_Inputs_Bit5_ALine_Monitor_IP	BOOL	Module Input Data - A-line Monitor IP
RIS_Inputs_Bit7_RandomBit	BOOL	Module Input Data - Random Bit
RIS_Inputs_Applic_Dept	SINT	Module Input Data High Byte - Application Dependent
RIS_Status	iMac_STATUS_DT	Module Status
RIS_Resist	INT	Module Resistance Value
RIS_Errors	iMac_ERROR_DT	Module Error Counters
RIS_LEDs	INT	LED Output Data

4.1.20 iMac_RO4_ModDT

This UDT stores the iMAC RO4 Isolation Output Module data. It has the following members.

Member Name	Data Type	Description
RO4_Outputs_Relay1	BOOL	Module Output Relays - Relay 1
RO4_Outputs_Relay2	BOOL	Module Output Relays - Relay 2
RO4_Outputs_Relay3	BOOL	Module Output Relays - Relay 3
RO4_Outputs_Relay4	BOOL	Module Output Relays - Relay 4
RO4_Status	iMac_STATUS_DT	Module Status

4.1.21 iMac_RTD1_FLAGS_ModDT

This UDT stores the iMAC RTD1 Flags Module data. It has the following members.

Member Name	Data Type	Description
RTD1_FLAGS_Bit0_RTD_SC	BOOL	Module Flags - RTD Short Circuit
RTD1_FLAGS_Bit1_RTD_OC	BOOL	Module Flags - RTD Open Circuit
RTD1_FLAGS_Bit2_RTD_Wire_FLT	BOOL	Module Flags - RTD Sense Wire Fault
RTD1_FLAGS_Bit3_Temp_OOR	BOOL	Module Flags - RTD Temperature Out of Range
RTD1_FLAGS_Bit4_Low_Temp	BOOL	Module Flags - RTD Low Temperature Alarm
RTD1_FLAGS_Bit5_High_Temp	BOOL	Module Flags - RTD High Temperature Alarm
RTD1_FLAGS_Status	iMac_STATUS_DT	Module Status
RTD1_FLAGS_Resist	INT	Module Resistance Value
RTD1_FLAGS_Errors	iMac_ERROR_DT	Module Error Counters

4.1.22 iMac_RTD_Temp_ModDT

This UDT stores the iMAC RTD Temperature Input Module data. It can be used for RTD1 and RTD3 modules. It has the following members.

Member Name	Data Type	Description
RTD_Temp_Input	INT	Module Temperature Input
RTD_Temp_Status	iMac_STATUS_DT	Module Status
RTD_Temp_Resist	INT	Module Resistance Value
RTD_Temp_Errors	iMac_ERROR_DT	Module Error Counters

4.1.23 iMac_RTD3_FLAGS_ModDT

This UDT stores the iMAC RTD3 Flags Module data. It has the following members.

Member Name	Data Type	Description
RTD3_FLAGS_Bit0_T1_ALM	BOOL	Module Flags - RTD3 Temp1 Alarm Setpoint
RTD3_FLAGS_Bit1_T2_ALM	BOOL	Module Flags - RTD3 Temp2 Alarm Setpoint
RTD3_FLAGS_Bit2_T3_ALM	BOOL	Module Flags - RTD3 Temp3 Alarm Setpoint
RTD3_FLAGS_Bit3_ADC_Fail	BOOL	Module Flags - RTD3 Internal Fault (ADC Fail)
RTD3_FLAGS_Bit4_T1_Temp_OOR	BOOL	Module Flags - RTD3 Temp1 Temperature Out of Range
RTD3_FLAGS_Bit5_T2_Temp_OOR	BOOL	Module Flags - RTD3 Temp2 Temperature Out of Range
RTD3_FLAGS_Bit6_T3_Temp_OOR	BOOL	Module Flags - RTD3 Temp3 Temperature Out of Range
RTD3_FLAGS_Bit7_Calib_Error	BOOL	Module Flags - RTD3 Calibration Error
RTD3_FLAGS_Bit8_T1_OL_Status	BOOL	Module Flags - RTD3 Temp1 Online Status
RTD3_FLAGS_Bit9_T2_OL_Status	BOOL	Module Flags - RTD3 Temp2 Online Status
RTD3_FLAGS_Bit10_T3_OL_Status	BOOL	Module Flags - RTD3 Temp3 Online Status
RTD3_FLAGS_Bit12_T1_Wire_FLT	BOOL	Module Flags - RTD3 Temp1 Sense Wire Fault
RTD3_FLAGS_Bit13_T2_Wire_FLT	BOOL	Module Flags - RTD3 Temp3 Sense Wire Fault
RTD3_FLAGS_Bit14_T3_Wire_FLT	BOOL	Module Flags - RTD3 Temp2 Sense Wire Fault
RTD1_FLAGS_Status	iMac_STATUS_DT	Module Status
RTD1_FLAGS_Resist	INT	Module Resistance Value
RTD1_FLAGS_Errors	iMac_ERROR_DT	Module Error Counters

4.1.24 iMac_SIM_G_ModDT

This UDT stores the iMAC SIM-G Module data. It has the following members.

Member Name	Data Type	Description
SIM_G_ALARMS_CH1_2	INT	Alarm Flags Channels 1 & 2
SIM_G_ALARMS_CH3_4	INT	Alarm Flags Channels 3 & 4
SIM_G_FLAGS	INT	Gasguard Flags
SIM_G_ANALOG_CH	INT[4]	Analogue Input Channels 1 to 4
SIM_G_DISPLAY_CH	INT[4]	Display Format Value Channels 1 to 4
SIM_G_RS485_ERRORS	INT	Error Count for RS 485 Communication
SIM_G_SERIAL_NUM	INT	SIM-G Serial Number
SIM_G_Status	iMac_STATUS_DT[16]	Module Status A0 to A15
SIM_G_Resist	INT[16]	Module Resistance Value A0 to A15
SIM_G_Error	iMac_ERROR_DT[16]	Module Error Counters A0 to A15

4.1.25 iMac_SIM_G2_ModDT

This UDT stores the iMAC SIM-G2 Module data. It has the following members.

Member Name	Data Type	Description
SIM_G2_ALARMS_CH1_2_CTRL1	INT	Alarm Flags Channels 1 & 2, Controller 1
SIM_G2_ALARMS_CH3_4_CTRL1	INT	Alarm Flags Channels 3 & 4, Controller 1
SIM_G2_ALARMS_CH1_2_CTRL2	INT	Alarm Flags Channels 1 & 2, Controller 2
SIM_G2_ALARMS_CH3_4_CTRL2	INT	Alarm Flags Channels 3 & 4, Controller 2
SIM_G2_ANALOG_CH_CTRL1	INT[4]	Analogue Input Channels 1 to 4, Controller 1
SIM_G2_DISPLAY_FORMATS	INT	Channel Display Format Values - Controllers 1 (low byte) and 2 (high byte).
SIM_G2_ANALOG_CH_CTRL2	INT[4]	Analogue Input Channels 1 to 4, Controller 2
SIM_G2_RS485_ERRORS_CTRL1	INT	Error Count for RS 485 Communication, Controller 1
SIM_G2_RS485_ERRORS_CTRL2	INT	Error Count for RS 485 Communication, Controller 2

SIM_G2_SERIAL_NUM	INT	SIM-G2 Serial Number
SIM_G2_Status	iMac_STATUS_DT[16]	Module Status A0 to A15
SIM_G2_Resist	INT[16]	Module Resistance Value A0 to A15
SIM_G2_Error	iMac_ERROR_DT[16]	Module Error Counters A0 to A15

4.1.26 iMac_SIM_P_ModDT

This UDT stores the iMAC SIM-P Module data. It has the following members.

Member Name	Data Type	Description
SIM_P_RS485_ERRORS	INT	Error Count for RS485 Communication
SIM_P_DATA_REGS	INT[16]	Data Registers 1 to 16
SIM_P_Status	iMac_STATUS_DT[17]	Module Status A0 to A16
SIM_P_Resist	INT[17]	Module Resistance Value A0 to A16
SIM_P_Error	iMac_ERROR_DT[17]	Module Error Counters A0 to A16

4.1.27 iMac_SIM_T_ModDT

This UDT stores the iMAC SIM-T Module data. It has the following members.

Member Name	Data Type	Description
SIM_T_ALARMS_CH1_4	INT	Alarm Flags Channels 1 to 4
SIM_T_ALARMS_CH5_8	INT	Alarm Flags Channels 5 to 8
SIM_T_INPUT_STATUS	INT	Trolex Input Status 1 to 8
SIM_T_RELAY_STATUS	INT	Trolex Relay Status 1 to 8
SIM_T_ANALOG_CH	INT[8]	Analogue Input Channels 1 to 8
SIM_T_SOFTWARE_VERSION	INT	Software Version *10 (Value divided by 10 i.e. 27 = version 2.7)
SIM_T_RS485_ERRORS	INT	Error Count for RS485 Communication
SIM_T_SERIAL_NUM	INT	SIM-T Serial Number

SIM_T_Status	iMac_STATUS_DT[16]	Module Status A0 to A15
SIM_T_Resist	INT[16]	Module Resistance Value A0 to A15
SIM_T_Error	iMac_ERROR_DT[16]	Module Error Counters A0 to A15

4.1.28 iMac_SSW_Control_ModDT

This UDT stores the iMAC SSW Module Control data. It has the following members.

Member Name	Data Type	Description
SSW_Control_Bit0_Setup_Mode	BOOL	Module Flags - Setup mode (1=Busy); The setup process is busy.
SSW_Control_Bit1_Setup_Success	BOOL	Module Flags - Setup successful (1=Success); No failures occurred during the setup process.
SSW_Control_Bit2_Setup_Failed	BOOL	Module Flags - Setup failed (1=Failed); The setup process failed due to a timeout or pulse rate failure.
SSW_Control_Bit3_S1_Pulse_Slow	BOOL	Module Flags - Sensor 1 pulse rate too slow (1=Failed); Rate < 50ppm.
SSW_Control_Bit4_S1_Pulse_Fast	BOOL	Module Flags - Sensor 1 pulse rate too fast (1=Failed); Rate > 5000ppm.
SSW_Control_Bit5_S2_Pulse_Slow	BOOL	Module Flags - Sensor 2 pulse rate too slow (1=Failed); Rate < 50ppm.
SSW_Control_Bit6_S2_Pulse_Fast	BOOL	Module Flags - Sensor 2 pulse rate too fast (1=Failed); Rate > 5000ppm.
SSW_Control_Bit7_Setup_Timeout	BOOL	Module Flags - Setup timeout (1=Timeout); Setup failed to complete within 4 minutes.
SSW_Control_Bit8_MC_Belt_State	BOOL	Module Flags - MC (belt run state) (1=Running); Usage: Indicate belt run condition.
SSW_Control_Bit9_Slip_Trip_Test	BOOL	Module Flags - Slip trip Test (1=Simulate trip); Usage: Test trip mechanism.
SSW_Control_Bit10_Reset_Trips	BOOL	Module Flags - Reset latched trips (1=Reset); Usage: Clear any latched trip flags; Requirements: No persistent trips present.
SSW_Control_Bit11_Setup_Enable	BOOL	Module Flags - Setup enable (1=Enable); Usage: Start the normalisation sequence;

		Requirements: Belt stopped, trips cleared.
SSW_Control_Status	iMac_STATUS_DT	Module Status
SSW_Control_Resist	INT	Module Resistance Value
SSW_Control_Errors	iMac_ERROR_DT	Module Error Counters

4.1.29 iMac_SSW_FLAGS_ModDT

This UDT stores the iMAC SSW Module Status data. It has the following members.

Member Name	Data Type	Description
SSW_FLAGS_Bit0_Trip_Summary	BOOL	Module Flags - Trip summary (1=Trips exist); An OR function of all 'Tripped' flags
SSW_FLAGS_Bit1_Brake_Relay	BOOL	Module Flags - Brake relay (1=Release); % speed > Brake release set point
SSW_FLAGS_Bit2_Seq_Relay	BOOL	Module Flags - Sequence relay (1=Energized); % Speed > Sequence relay activation set point
SSW_FLAGS_Bit3_CV_Stopped	BOOL	Module Flags - Conveyor stopped (1=Stopped); No pulses on either sensor, for a period of 20x slowest sensor pulse rate
SSW_FLAGS_Bit4_S1_Pulses_FLT	BOOL	Module Flags - Sensor 1 pulses fault (1=Tripped); Inhibit timers expired, and drive pulse rate = 0
SSW_FLAGS_Bit5_S2_Pulses_FLT	BOOL	Module Flags - Sensor 2 pulses fault (1=Tripped); Inhibit timers expired, and drive pulse rate = 0
SSW_FLAGS_Bit6_S1_Conn_FLT	BOOL	Module Flags - Sensor 1 connection fault (1=Tripped); Drive Sensor is open/short circuit
SSW_FLAGS_Bit7_S2_Conn_FLT	BOOL	Module Flags - Sensor 2 connection fault (1=Tripped); Idler Sensor is open/short circuit
SSW_FLAGS_Bit8_Slip_Trip	BOOL	Module Flags - Slip trip (1=Tripped); The difference between belt and drive speed > slip trip margin setting.
SSW_FLAGS_Bit9_UO_Speed_Err	BOOL	Module Flags - Idle roller Under/Over speed (1=Tripped); Belt speed is outside the under/over speed margin setting.

SSW_FLAGS_Bit10_Internal_Error	BOOL	Module Flags - SSW internal error (1=Tripped); EEPROM Error (checked at node power-up)
SSW_FLAGS_Bit13_Slip_Inh_TMR	BOOL	Module Flags - Slip trip inhibit timer (1=Active); Reload and timer start on MC 0 -> 1
SSW_FLAGS_Bit14_UO_Inh_TMR	BOOL	Module Flags - Under/Over trip inhibit timer (1=Active); Reload and timer start on MC 0 -> 1
SSW_FLAGS_Bit15_Sensor_Num	BOOL	Module Flags - Number of sensors; 0=1 sensor (Only an idler sensor exists.); 1=2 sensors (There is both a drive and an idler sensor).
SSW_FLAGS_Status	iMac_STATUS_DT	Module Status
SSW_FLAGS_Resist	INT	Module Resistance Value
SSW_FLAGS_Errors	iMac_ERROR_DT	Module Error Counters

4.1.30 iMac_SSW_Value_ModDT

This UDT stores the iMAC SSW Module % Slip, % Speed or Linear Speed value data. It has the following members.

Member Name	Data Type	Description
SSW_Value	INT	Module Register Value
SSW_Value_Status	iMac_STATUS_DT	Module Status
SSW_Value_Resist	INT	Module Resistance Value
SSW_Value_Errors	iMac_ERROR_DT	Module Error Counters

4.1.31 iMac_Modules_DT

This UDT stores iMAC Module data for all possible types of modules in a network of 256 modules. It has the following members.

Member Name	Data Type	Description
AIM_FLAGS_Modules	iMac_AIM_FLAGS_ModDT[256]	Storage for data from up to 256 of these modules in a network.
AIM_AI_Modules	iMac_AIM_AI_ModDT[256]	Storage for data from up to 256 of these modules in a network.
AIM_Power_Modules	iMac_AIM_Power_ModDT[256]	Storage for data from up to 256 of these

		modules in a network.
DI4_Modules	iMac_DI4_ModDT[256]	Storage for data from up to 256 of these modules in a network.
DI8_Modules	iMac_DI8_ModDT[256]	Storage for data from up to 256 of these modules in a network.
GAI3_FLAGS_Modules	iMac_GAI3_FLAGS_ModDT[256]	Storage for data from up to 256 of these modules in a network.
GAI3_Analog1_Modules	iMac_GAI3_AI_ModDT[256]	Storage for data from up to 256 of these modules in a network.
GAI3_Analog2_Modules	iMac_GAI3_AI_ModDT[256]	Storage for data from up to 256 of these modules in a network.
GAI3_Analog3_Modules	iMac_GAI3_AI_ModDT[256]	Storage for data from up to 256 of these modules in a network.
IIM_Modules	iMac_IIM_ModDT[256]	Storage for data from up to 256 of these modules in a network.
LED4_Modules	iMac_LED4_ModDT[256]	Storage for data from up to 256 of these modules in a network.
RIS_Modules	iMac_RIS_ModDT[256]	Storage for data from up to 256 of these modules in a network.
RO4_Modules	iMac_RO4_ModDT[256]	Storage for data from up to 256 of these modules in a network.
RTD1_FLAGS_Modules	iMac_RTD1_FLAGS_ModDT[256]	Storage for data from up to 256 of these modules in a network.
RTD1_Temp_Modules	iMac_RTD_Temp_ModDT[256]	Storage for data from up to 256 of these modules in a network.
RTD3_FLAGS_Modules	iMac_RTD3_FLAGS_ModDT[256]	Storage for data from up to 256 of these modules in a network.
RTD3_Temp1_Modules	iMac_RTD_Temp_ModDT[256]	Storage for data from up to 256 of these modules in a network.
RTD3_Temp2_Modules	iMac_RTD_Temp_ModDT[256]	Storage for data from up to 256 of these modules in a network.
RTD3_Temp3_Modules	iMac_RTD_Temp_ModDT[256]	Storage for data from up to 256 of these modules in a network.
SIM_G_Modules	iMac_SIM_G_ModDT[16]	Storage for data from up to 16 of these

		modules in a network.
SIM_G2_Modules	iMac_SIM_G2_ModDT[16]	Storage for data from up to 16 of these modules in a network.
SIM_P_Modules	iMac_SIM_P_ModDT[128]	Storage for data from up to 128 of these modules in a network.
SIM_T_Modules	iMac_SIM_T_ModDT[16]	Storage for data from up to 16 of these modules in a network.
SSW_FLAGS_Modules	iMac_SSW_FLAGS_ModDT[256]	Storage for data from up to 256 of these modules in a network.
SSW_Control_Modules	iMac_SSW_Control_ModDT[256]	Storage for data from up to 256 of these modules in a network.
SSW_PC_Slip_Modules	iMac_SSW_Value_ModDT[256]	Storage for data from up to 256 of these modules in a network.
SSW_PC_Speed_Modules	iMac_SSW_Value_ModDT[256]	Storage for data from up to 256 of these modules in a network.
SSW_Linr_Speed_Modules	iMac_SSW_Value_ModDT[256]	Storage for data from up to 256 of these modules in a network.

4.2 AOIs

This subsection will describe four RSLogix5000 add-on instructions that have been written for retrieving the EtherNet/IP data from the iMAC2. Instruction parameters and logic (where relevant) is to be described.

4.2.1 iMac_Demux_AOI

This AOI reads in data from the iMAC2 EIP module assembly instance, and distributes it to iMAC2 bug UDT instances and the iMAC2 Controller UDT instance. It uses a network setup lookup table to determine where the bug data needs to be distributed. The AOI parameters are as follows.

Name	Usage	Data Type	Description
InputAssembly	InOut	INT[100]	Input assembly data from Ethernet
iMac_Network_Config	InOut	iMac_Network_Config_DT	iMAC network configuration lookup table.
iMac_Controller	InOut	iMac_Controller_DT	iMAC Controller UDT
iMac_Modules	InOut	iMac_Modules_DT	All bug data.

The iMac_Demux_AOI InputAssembly input parameter is of the form described earlier in *Table 3.1: iMAC2 Controller Input Assembly Instance Data Structure*. The AOI logic works in two stages:

- In stage 1, the Data, Status, Resistance and Error Count data for each of the four consecutive modules (with the first module node address specified in Start Block Address) is stored to the iMac_Controller DATA, STATUS, RESIST and ERROR arrays. The next block of input assembly data is stored to the iMac_Controller Runtime data. Lastly, the General Buffer and NV Memory data is stored to the GENBUFF and NVM arrays. In time, the data for all bugs (modules) will eventually be stored to the iMac_Controller UDT instance.
- In stage 2, the iMac_Network_Config parameter is consulted, and when there is a valid module type, the node index is used to transfer the DATA, STATUS, RESIST and ERROR information from the iMac_Controller array (at the node index) to the iMac_Modules UDT instances, according to the module type and index. For example, if there is a DI4 module at node address 7, then iMac_Network_Config[7] = 15 (the module type); data will be transferred from iMac_Controller.DATA[7] to iMac_Modules.DI4_Modules[7].DI4_Inputs_IPx, and so on for the STATUS[7], RESIST[7] and ERROR[7] data.

4.2.2 iMac_Clear_Data_AOI

This AOI clears all iMAC2 module and controller instance data. It is intended to be used on first scan only. The AOI parameters are as follows.

Name	Usage	Data Type	Description
iMac_Controller	InOut	iMac_Controller_DT	iMAC Controller UDT
iMac_Modules	InOut	iMac_Modules_DT	All bug data.

4.2.3 iMac_Errors_Assign_AOI

This AOI Assigns iMAC module errors to all types of iMAC modules. It is used within iMac_Demux_AOI as a repeatable function call, to make code more readable and compact. The AOI parameters are as follows.

Name	Usage	Data Type	Description
iMac_Module_Errors	InOut	iMac_ERROR_DT	iMAC Module error word
iMac_Controller_Error	Input	INT	iMAC Error Word read in from controller

4.2.4 iMac_Status_Assign_AOI

This AOI assigns iMAC module status bit definitions to all types of iMAC modules. It is used within iMac_Demux_AOI and iMac_Clear_Data_AOI as a repeatable function call, to make code more readable and compact. The AOI parameters are as follows.

Name	Usage	Data Type	Description
iMac_Module_Status	InOut	iMac_STATUS_DT	iMAC Module status word
iMac_Controller_Status	Input	INT	iMAC Status Word read in from controller

4.3 RSLogix5000 Program/Routine Usage

The minimum Program/Routine requirements for getting iMAC2 EtherNet/IP data in RSLogix5000 are shown in Figure 5. They are:

- Creation of a Generic Ethernet Module in the RSLogix5000 I/O Configuration tree. This is shown in Figure 6 and Figure 7.
- Tags for loading, configuring and storing the iMAC2 data. The tags shown in Figure 5 include:
  - Imac:I.Data, the Assembly Instance tag, which is automatically generated by RSLogix5000 when the Ethernet module is created.
  - IMAC_Network, the instance of iMac_Network_Config_DT for entering the iMAC2 network configuration lookup table.
  - IMAC_Control, the instance of iMac_Controller_DT for storing the data read from the iMAC2 network, which is the iMAC2 Controller data and the raw modules data.
  - IMAC_Modules_all, the instance of iMac_Modules_DT for storing the module data in more readable and accessible form.
- A call to a routine to clear all the iMAC2 EIP data instances. This routine should use the iMac_Clear_Data_AOI, and need only be called at first scan.
- A call to a routine to set up the network configuration for the iMAC2 module network. This routine should contain instructions for assigning module types at their node addresses; e.g. if a DI4 module (type = 15) is at node address 7, then use *IMAC_Network.Lookup_Table[7].Module_Type := 15;*
- Lastly, a call to an iMac_Demux_AOI instance to read EtherNet/IP data and distribute it to the iMAC2 Controller and Modules tags, based on the iMAC2 Network setup.

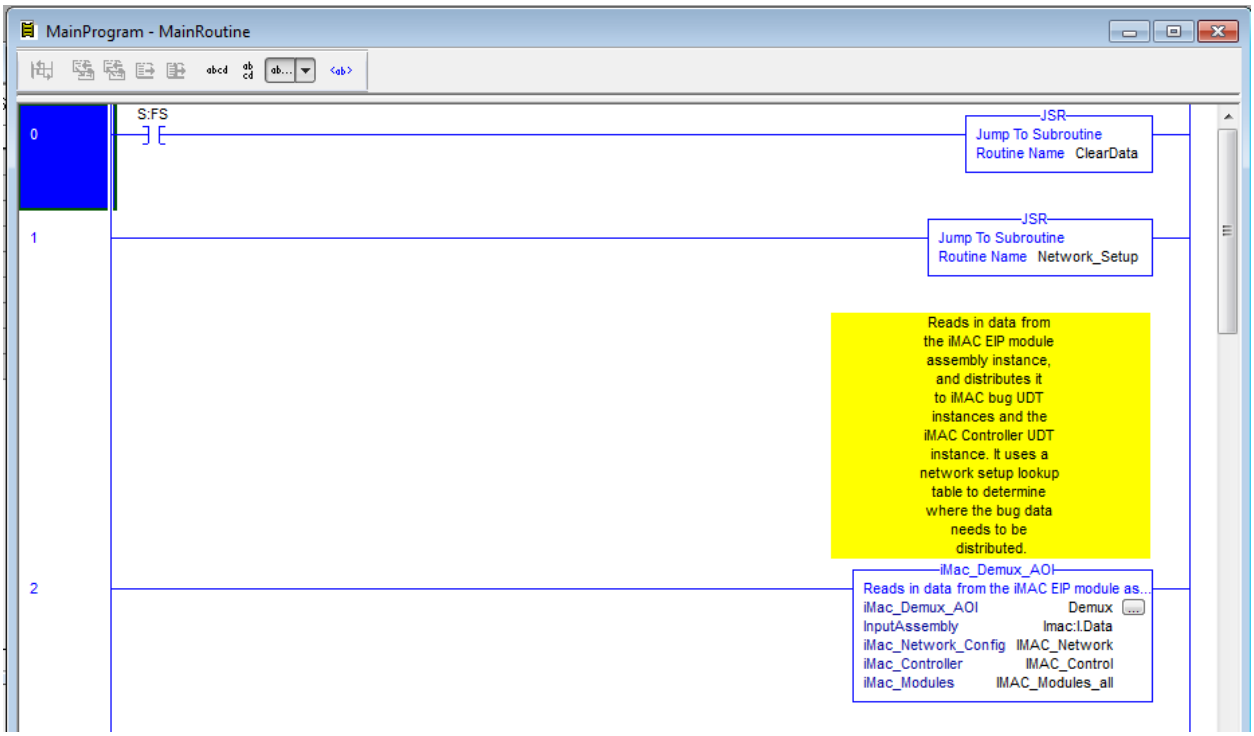


Figure 5: Minimum Program/Routine requirements for getting iMAC2 EtherNet/IP data in RSLogix5000

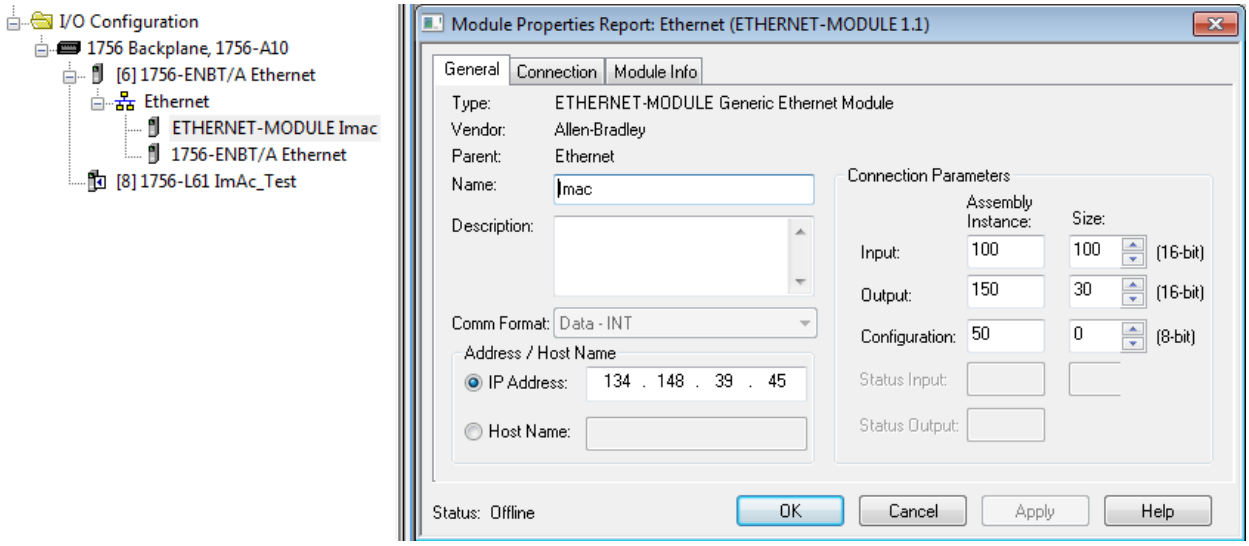


Figure 6: Generic Ethernet Module setup for iMAC2 EIP data.

The “Use Unicast Connection over EtherNet/IP check box needs to be ticked, and the appropriate RPI needs to be entered, as follows in Figure 7.

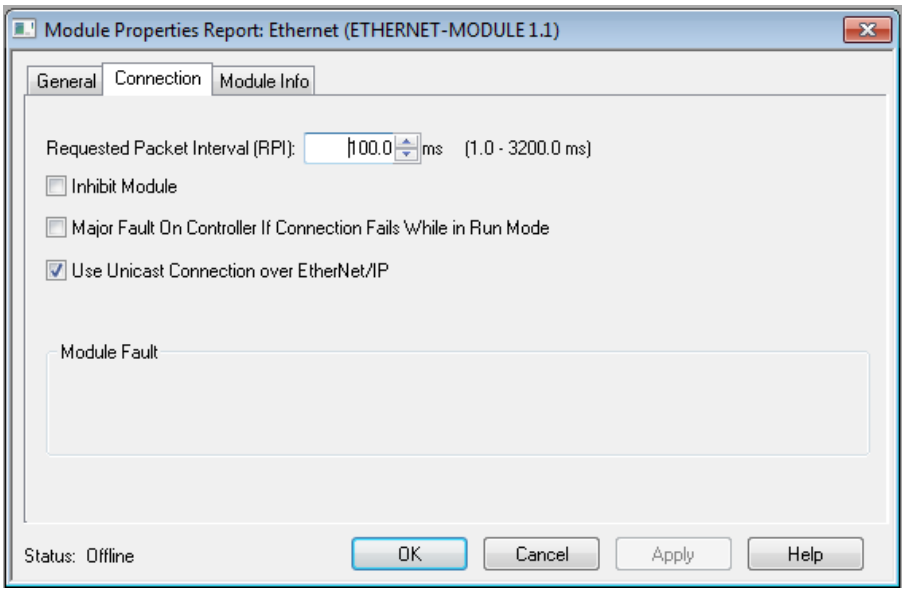


Figure 7: Connection parameter setup.

The requested packet interval is configurable, and to guarantee all iMAC module data is sent to the PLC this interval needs to be set to a rate faster than the iMAC controller is scanning its connected modules (referred to as the iMAC Controller's "linespeed"). The linespeed is set by the iMAC SLP code, and can be configured in the range from 300 to 1000.

There are three commonly used linespeeds: 300, 500 and 1000. The following table specifies the maximum EIP "packet interval time" that can be used for each of the commonly used linespeeds.

Table 6: Maximum EIP Packet Interval

iMAC Linespeed	EIP Packet Interval (max)
1000	100 ms
500	225 ms
300	400 ms

The requested packet interval defaults to 225msec, with a maximum allowed being 400msec.

If there is a SIM-G, SIM-G2, SIM-P or SIM-T module in the iMAC2 network, this needs setting up in a more complex way because it takes up 16 consecutive node addresses (or 17 for a SIM-P module). Additional network configuration data is used to specify the SIM-G/SIM-G2/SIM-P/SIM-T unit number and the sub-index of the node within the 16 (or 17) consecutive node addresses. This is better explained with an example of SIM-G data setup as follows:

```
IMAC_Network.Lookup_Table[node address].Module_Type := 37;           // SIM-G type
IMAC_Network.Lookup_Table[node address].Module_Type_Data1 := unit_number;       //0 to 15
IMAC_Network.Lookup_Table[node address].Module_Type_Data2 := 0;
IMAC_Network.Lookup_Table[node address+1].Module_Type := 37;        // SIM-G type
IMAC_Network.Lookup_Table[node address+1].Module_Type_Data1 := unit_number;    //0 to 15
IMAC_Network.Lookup_Table[node address+1].Module_Type_Data2 := 1;
IMAC_Network.Lookup_Table[node address+2].Module_Type := 37;        // SIM-G type
IMAC_Network.Lookup_Table[node address+2].Module_Type_Data1 := unit_number;    //0 to 15
IMAC_Network.Lookup_Table[node address+2].Module_Type_Data2 := 2;
and so on to
IMAC_Network.Lookup_Table[node address+15].Module_Type := 37;       // SIM-G type
IMAC_Network.Lookup_Table[node address+15].Module_Type_Data1 := unit_number;   //0 to 15
IMAC_Network.Lookup_Table[node address+15].Module_Type_Data2 := 15;
```

4.4 Example Setup

This example is based on the iMAC2 Demonstration Box shown in Figure 8.

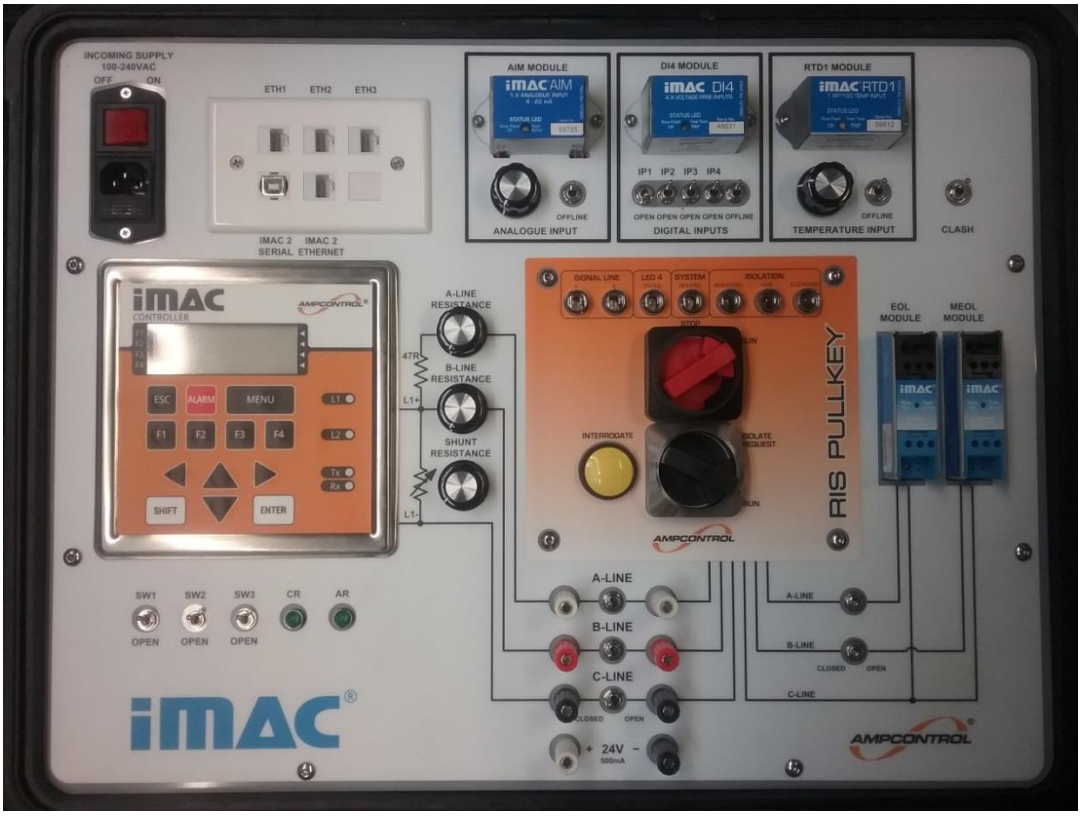


Figure 8: iMAC2 Demonstration Box

It has three modules – an AIM module, a DI4 module and an RTD1 module. When running, the web interface shows the online modules as in Figure 9. The modules and addresses are as follows:

- iMAC address 10: EOL module.
- iMAC address 20: DI4 module.
- iMAC address 28: AIM_FLAGS module.
- iMAC address 29: AIM_AI module.
- iMAC address 30: AIM_Power module.
- iMAC address 40: RTD1_FLAGS module.
- iMAC address 41: RTD1_Temp module.
- iMAC address 96: MEOL module.

In RSLogix5000, this network information is entered as follows:

```
IMAC_Network.Lookup_Table[20].Module_Type := 15;      // DI4 type
IMAC_Network.Lookup_Table[28].Module_Type := 48;      // AIM_FLAGS type
IMAC_Network.Lookup_Table[29].Module_Type := 49;      // AIM_AI type
IMAC_Network.Lookup_Table[30].Module_Type := 50;      // AIM_Power type
IMAC_Network.Lookup_Table[40].Module_Type := 54;      // RTD1_FLAGS type
IMAC_Network.Lookup_Table[41].Module_Type := 55;      // RTD1_Temp_Input type
```

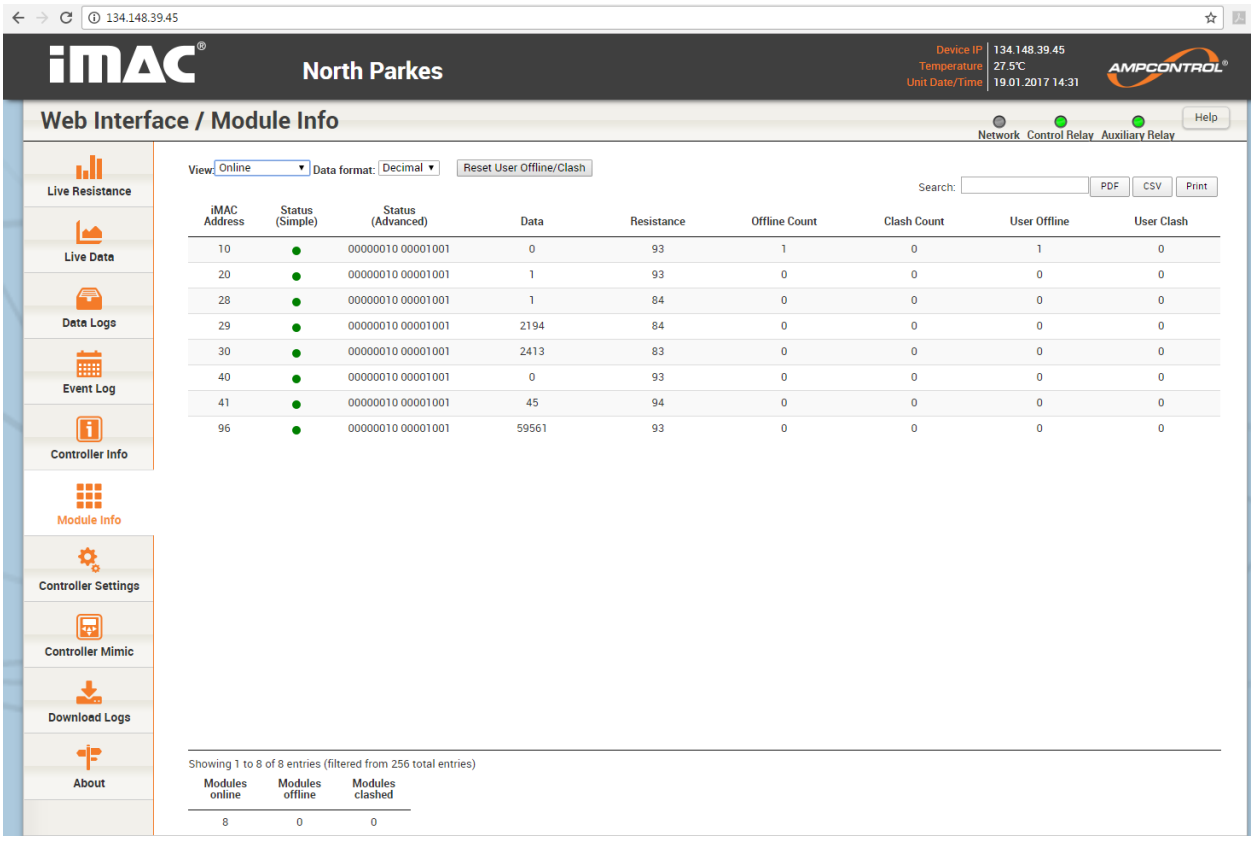


Figure 9: iMAC web interface online modules.

When the PLC code is running, the iMAC2 data will be retrieved from the EIP instance and will be distributed to the module arrays as needed. For example, the AIM Power module at node address 30 will have its data inserted into IMAC_Modules_all.AIM_Power_Modules[30] - Figure 10 shows the Power supply data (24.22V) and resistance value (93 ohms) transferred correctly.

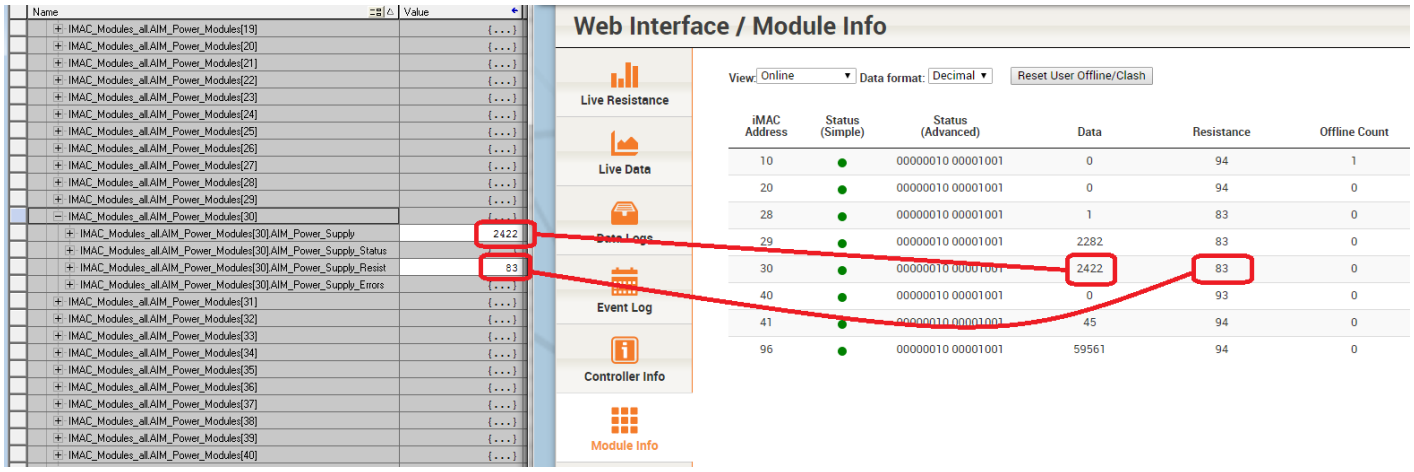


Figure 10: Node 30 data transferred to the PLC.

Once the iMAC2 data is transferred to the PLC correctly, it can easily be referenced and used in the automation project via aliasing, or via direct tag references such as:

Important_Input_Bool := IMAC_Modules_all.DI8_Modules[7].DI8_Inputs_IP3