ScadaFlex PicoBrick

Distributed I/O & RTU Modules

- 7 Models Available:
  12 Discrete Inputs (12/24 or 120V)
  12 Discrete FET (protected transistor) Outputs
  16-bit Analog Inputs - 5Vdc
  16-bit Analog Inputs - 20mA
  12-bit Analog Outputs - 20mA
  Combo [3 16-bit AI, 3 DI (12/24 or 120V), 2 DO]
  Discrete I/O 6 Discrete Inputs (12/24 or 120V) 6 Discrete FET Outputs

- Modular I/O Expansion to 3000 points distributed over 4,000ft.
- Support for Modbus RTU, BrickNet peer-to-peer, and DF1 communications
- Back-to-back I/O bridge – Master Mode
- Built-in “store-and-forward” messaging for radio based systems
- Dual-standard communications interface; RS-232 and RS-485
- All I/O is isolated and transient, surge, overload and polarity protected
- All Discrete Inputs have pulse and runtime totalizers, and rate
- All Discrete Outputs have programmable Flash function
- All Analog Inputs have totalizers with programmable sampling time
- Dual Watchdog Timers; Comm & Module CPU
- Low-power DC for battery/solar applications
- Hot-swappable with removable terminal blocks
- Discrete I/O have individual LED status indicators
- Compact & DIN rail mounting for lower panel cost
- -40°C to +75°C Operating Temperature Range
- 3-year factory warranty

PicoBrick Distributed I/O

Technical Reference Manual

Copyright Notice

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ISaGRAF is a trademark of ICS Triplex, Inc.

IBM and PC are trademarks of International Business Machines Corporation

In This Manual . . .

This manual provides the technical hardware information required for system design and installation of PicoBrick Distributed I/O Modules.

If you have just purchased a PicoBrick, we hope that you are as pleased using it as we have been developing it.

If you are reading this manual looking at a future purchase, we hope that you will consider PicoBrick I/O when you have an application that needs modular I/O expansion or a low-cost RTU.

Support

If you have questions or need help with an application, we hope that you'll take advantage of our free technical support. Simply call us at:

(800) 888-1893

If you need to send us a fax, use either:

(530) 888-1300 or (530) 888-7017

If you prefer e-mail, especially if you want to send us a sample of a program or other files, you can e-mail us at:

support@www.iclinks.com

For additional technical information including datasheets, manuals and software, visit our web site at:

www.iclinks.com

Certifications

PicoBrick I/O Modules are tested to the following certifications:

North America:

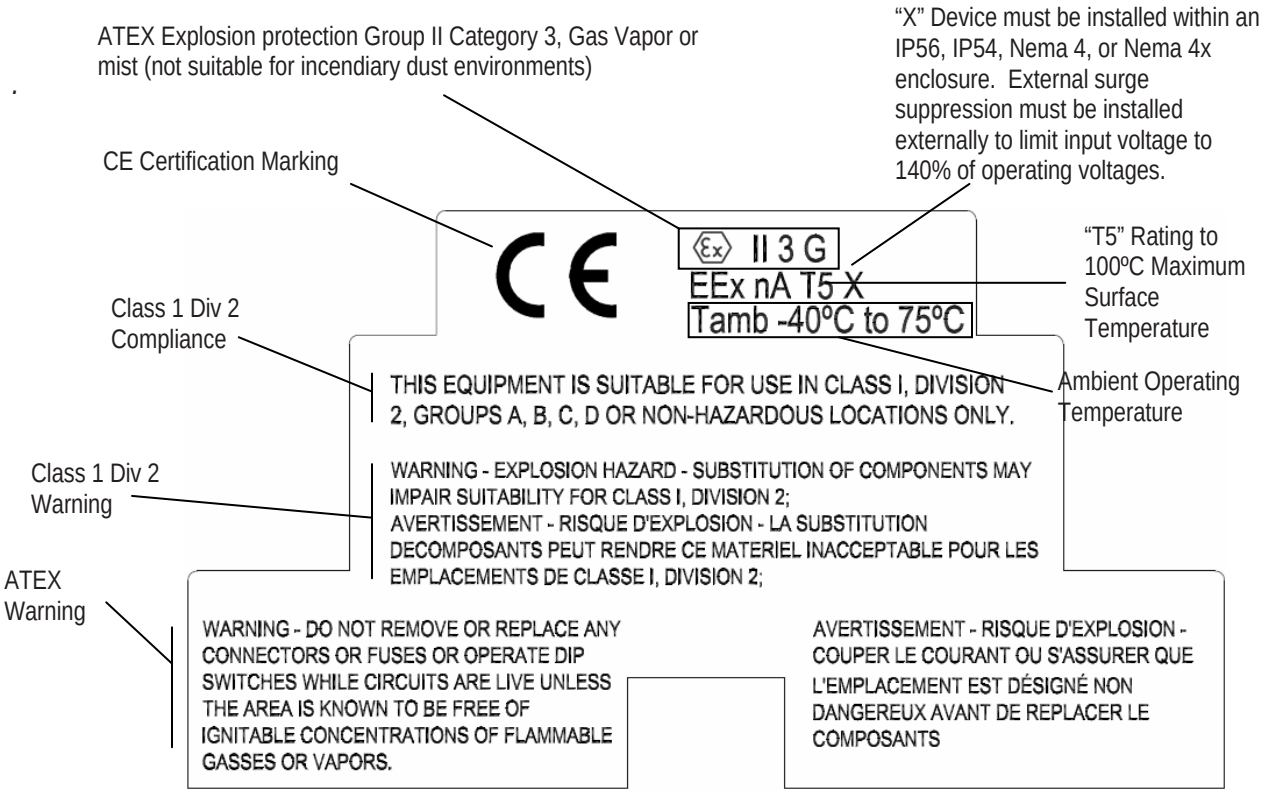
UL 508, CSA 142, ANSI/ISA-12.12.01-2000: April , CSA-C22.2 NO. 213-MI987 (R 1999); Class I Division 2 Groups A, B, C, and D: by INTERTEK.

European Union:

EN 60079-15: Sept 2003 ATEX Group II Category 3 Gas Vapor or Mist Explosion protection

Protection Type nA: In normal and some abnormal conditions, the equipment is not capable of igniting an explosive gas atmosphere.

All certified PicoBrick I/O Modules come with the following compliance marking tag



Contents

Introduction

PicoBricks are easy-to-use distributed I/O modules. They can be connected to ScadaFlex or EtherLogic controllers for I/O expansion, connected to Programmable Logic Controllers (PLCs) or PC computers as rugged field I/O, or used with radios or leased-line modems to serve as low-cost Remote Terminal Units (RTUs).

PicoBricks go beyond traditional "dumb" I/O modules by providing local intelligent signal conditioning and data acquisition.

Modular I/O Expansion

PicoBricks provide a very modular means of adding I/O capacity as needed, without the extra cost, wasted space and constraints of card racks. Need more I/O? Snap on a module. Want to add some I/O a few hundred yards away? String a single twisted pair of wires and you're up and running!

Built-in Networking

PicoBricks come network-ready with a dual-function (RS-485 and RS-232) serial communications interface. The RS-485 port can be used for low-cost 2-wire networking while RS-232 is a simple point-to-point interface to radios and modems as well as PCs. PicoBricks support "store-and-forward" messaging to extend the effective range of radio based systems by using the RTU as a digital repeater, without additional radio hardware.

Open Architecture

PicoBricks use the Modbus RTU protocol, one of the most common protocols used in control systems. This protocol is supported by thousands of other hardware and software products including all of the common PC-based MMI software packages from manufacturers such as Wonderware, Intellusion, Iconics, and National Instruments. Picobricks also talk DF1 but require a Toolbox configuration to do so. The change is not automatic.

Peer-to-peer Communications

For true peer-to-peer operation Picobrick modules support ICL's BrickNet protocol for use with ICL EtherLogic and ScadaFlex Plus controller families. Protocol detection between Modbus and BrickNet is automatic.

Local I/O Processing

PicoBricks perform local I/O processing to off-load time-sensitive operations from a Host system.

PicoBricks with Discrete Inputs totalize input transitions and on-time (runtime) and calculate pulse rates for every input. Applications include using digital pulse output meters for precise totalized flow and wattage calculations, as well as real-time flow rate and power usage information. Runtime is widely used for wear leveling between pumps or motors, and as the basis of an equipment preventive maintenance program.

PicoBricks with Analog Inputs totalize the value of every Analog Input at a periodic sampling rate, especially useful for totalized flows and wattage applications using analog output type meters.

PicoBricks with Discrete Outputs can be commanded to flash individual outputs at a precise periodic rate independent of communications and I/O scan rates, primarily for alarm annunciation.

Wide Power Range and Low Power Operation

PicoBricks are designed for use in solar and battery backed applications. They operate over a wide range of DC power (10 to 28Vdc) and consume very little power.

Internal Power Monitor

All PicoBricks have an internal analog input channel to monitor the input voltage (power) level. The input voltage may be read in a Modbus register. This feature is especially useful in battery backed and solar applications to check the actual battery voltage level under load.

Dual Watchdog Timers

PicoBricks have two watchdog timers; one that monitors the sanity of the internal microprocessor, the second that monitors activity on the communications link.

The first watchdog timer will automatically reset and restart the modules microprocessor if it senses that it is not operating properly. This timer is not user configurable.

The second timer will reset all outputs (analog or discrete) if there is no communications activity for a preset period of time. This timer is user settable via a Modbus register. Setting the timer to “0” disables this feature. This timer is used when it is critical to stop equipment when the communications link is broken and the “Host” system is no longer in control. An example is shutting off pumps at a pumping station when there is a broken communications link so that the pumps do not continue to run forever without a “stop” signal.

Rugged I/O

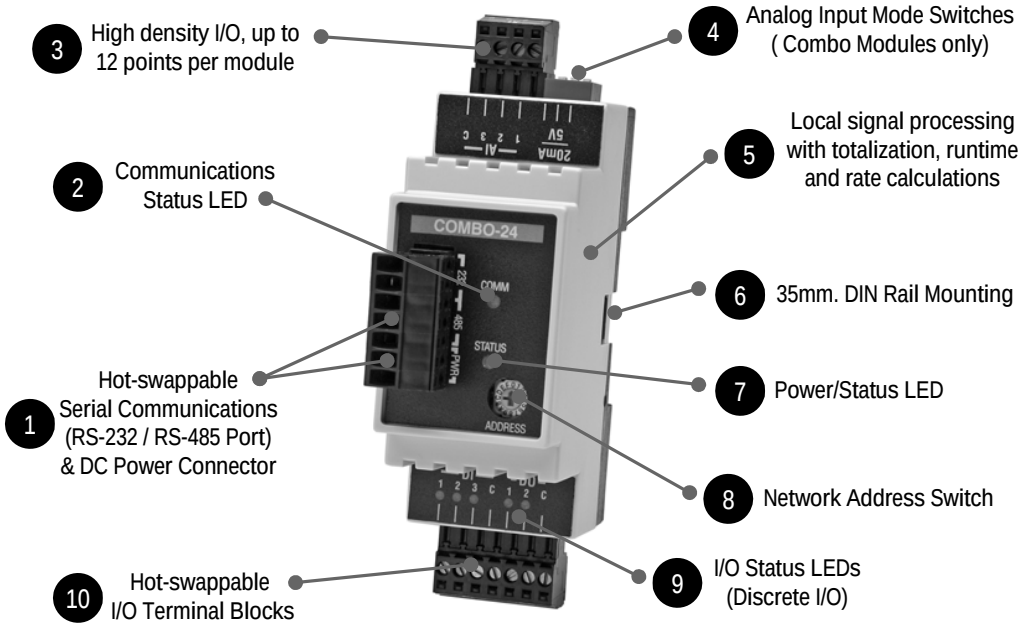
All field I/O interfaces are isolated and protected against overloads, transients, surges, and reverse polarity. Transorb transient protectors and self resetting polymer fuses are used throughout. When the fault condition is corrected, the module automatically resumes normal operation.

Industry Leading Warranty

PicoBricks are backed by an industry leading 3-year factory warranty.

PicoBrick Familiarization

The diagram below highlights the main physical features of PicoBrick I/O Modules that are discussed in the following pages.



1 Hot-swappable Serial Communications & DC Power Connectors

Removable terminal blocks for RS-232/RS-485 Communications and DC Power. The RS-485 interface supports up to 256 PicoBricks on a single network. DC Power is 10 to 28Vdc.

2 Communications Status LED

Bicolor (red/green) Transmit and Receive Data LED indicator shows network communications activity; RED for receive data (into PicoBrick), GREEN for transmit data (from PicoBrick).

3 High Density I/O

Up to 12 Discrete I/O points, 8 Analog Input points or 6 Analog Output Points per module. The compact PicoBrick package saves precious panel space and makes it easy to retrofit systems with more I/O.

4 Analog Input Mode Switches

Combo I/O Modules have built-in selectable precision current sense resistors that are switched out for Voltage mode or in for Current mode on each analog input channel. Accommodates both voltage and current output sensors without buying two separate modules.

5 Local Signal Processing

PicoBricks totalize Discrete Input transitions, runtime and pulse rate. Discrete Outputs have programmable Flash function. Analog Inputs have noise rejection signal processing and totalization.

6 35mm. DIN Rail Mounting

PicoBricks snap onto a standard 35mm. DIN rail. A release catch is accessible under the lower I/O terminal block (unplug terminal block for access).

7 Power/Status LED

Combined function LED status indicator. On solid GREEN for normal operation (power ON), flashes RED for communications failure.

8 Network Address Switch

16-position rotary switch for easy front panel selection of the PicoBricks network address. The actual network address is the switch setting plus a base address in a Modbus register in EEROM. The default base address is zero, but configuring the base address allows PicoBrick to be set to any of the possible 255 Modbus addresses. PicoBricks always respond to address 255 regardless of the switch and EEROM settings, in order to simplify setup. Do not use 255 as an address in a network! Address 0 is not supported.

9 Discrete I/O Status LEDs

Modules with Discrete Inputs/Outputs have amber LED status indicators right above the field wiring terminal blocks to simplify system test and troubleshooting.

10 Hot-swappable I/O Terminal Blocks

I/O Terminal Blocks can be removed and reinserted easily, without taking your system down.

Power

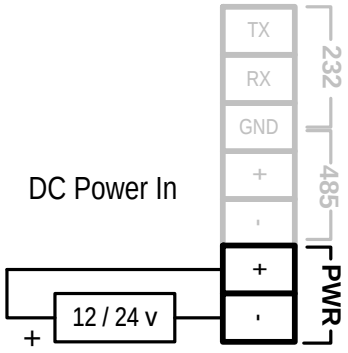
PicoBricks are designed to operate from DC power, typically either 12 or 24 volts, although they are specified to operate over a range of 10 to 28Vdc. The power consumption of a PicoBrick is very low; typically about 30mA (0.030A) to 50mA (0.050A). Because of their low power consumption and wide input power range, they are ideal for solar or battery backed applications.

The ScadaFlex DC Power Supply or ScadaFlex UPS are recommended power sources because they both have the same wide range temperature rating as PicoBricks as well as ICL's ScadaFlex Plus and EtherLogic Series Controllers. The ScadaFlex UPS is especially worth considering as economical insurance against unreliable “brownout” prone AC power sources.

Power Wiring

On the front face of all PicoBricks is a single removable terminal block with terminations for both communications and power. The power connections are the two terminals located towards the bottom of the terminal block. They are labeled “PWR” on one side, and (+) and (-) on the other.

Typical DC power wiring to a PicoBrick I/O module is shown below:

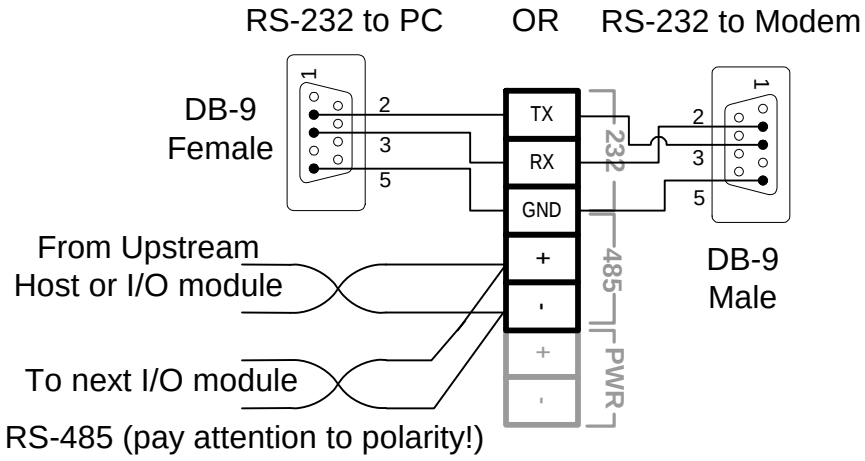


Typical DC Power Wiring - PicoBrick I/O Module

Communications Interfaces

The most common serial communications standards for SCADA and industrial control systems are RS-232 for short point-to-point connections and RS-485 for longer point-to-point and networked communications. PicoBricks have a dual-interface serial port that supports both RS-232 and RS-485 operation.

The communications connections are on the same terminal block as the power connections on the front face of the PicoBrick. The typical RS-232 and RS-485 wiring terminations to a PicoBrick are shown in the diagram below.



Typical RS-232 & RS-485 Communications Wiring - PicoBrick I/O Module

RS-232 Serial Communications Interface

The PicoBrick RS-232 interface is a simple 3-wire configuration. It does not require (or support) any modem control lines. The RS-232 port connections are available on a removable terminal block for ease of wiring in the field. The typical wiring to a female 9-pin "D" connector (such as for a PC computer) is shown in the diagram above.

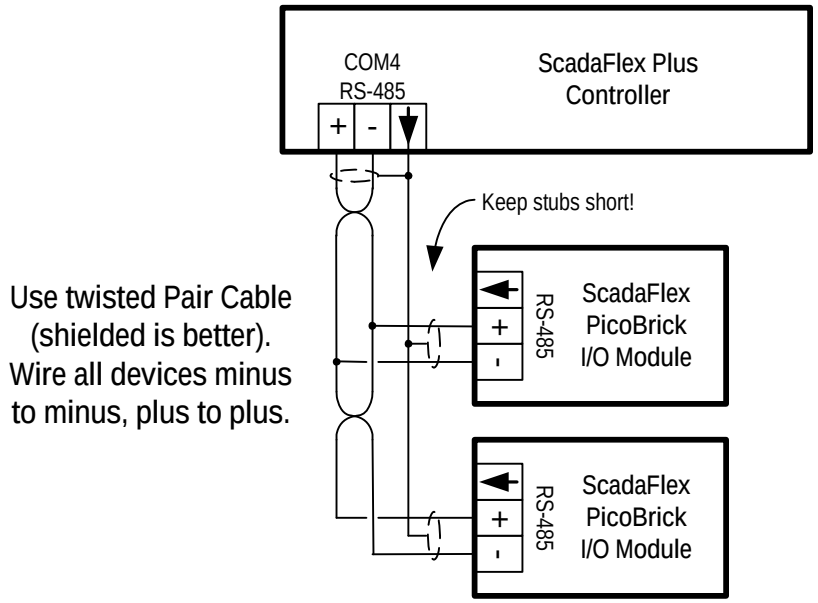
RS-485 Serial Communications Interface

RS-485 is a 2-wire communications interface designed for networked operation spanning distances of up to 4,000 ft. PicoBrick I/O modules are frequently used with ScadaFlex Plus and EtherLogic Controllers for I/O expansion. These controllers have one or more RS-485 ports that are the easiest to wire in the field and have the best noise immunity for industrial environments. An RS-485 network of PicoBricks can be distributed over a distance of 4,000ft., allowing the PicoBricks to be located near field devices to minimize wiring cost. Since the PicoBrick RS-485 port is NOT isolated from the power inputs, attention should be paid to power wiring in order to avoid ground loops. A power supply can be

shared when several PicoBricks are located close together, but separate power supplies are recommended at each location when PicoBricks are distributed over a wide area. Note that the field I/O connections ARE all isolated from the power and communications interfaces.

Although the original RS-485 standard allowed for only 32 devices on a network, the RS-485 interface in PicoBrick I/O modules (as well as ScadaFlex Plus and EtherLogic Controllers) is specially designed to allow up to 256 devices to share the same network. With up to 12 I/O points per module, a network of 254 PicoBricks provides over 3,000 I/O points!

The RS-485 connections on a PicoBrick use 3 pins on a 7-pin removable terminal block; 2 data pins, and a ground pin. A typical PicoBrick RS-485 network uses a twisted pair cable. If the cable is shielded (recommended), the shield should be connected to the ground pin. The RS-485 wiring of two PicoBricks to a Controller is shown below.

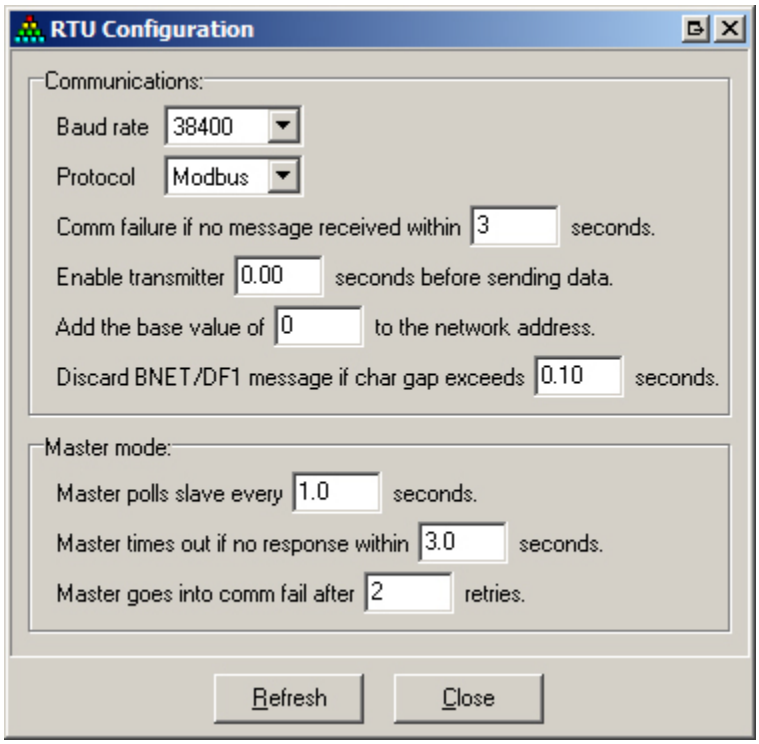


Typical ScadaFlex Plus/PicoBrick RS-485 Network

Traditionally, RS-485 networks use a 120Ω resistor termination at each end of the network. This technique does not work well with certain protocols such as Modbus that do not have a lead-in message header to eliminate garbage on the beginning of a message caused by a “floating” (non-driven) cable. PicoBrick I/O modules have series termination resistors that eliminate this problem. In most cases, separate termination is not required. If termination is required, AC termination (120 ohm resistor in series with a 1nF capacitor) should be used. Terminator modules are available from ICL.

RTU Configuration with the I/O Toolbox: Communications

The ScadaFlex I/O Toolbox is used to configure and exercise PicoBrick modules when they are connected to a PC computer. The settings that configure the basic communications parameters are accessed via the RTU Configuration window shown here.



Baud Rate: This parameter sets the communications character rate, from 2400 to 115,200 baud.

Protocol: This parameter sets the communications protocol, either Modbus / Bricknet or DF1.

Comm Fail Time: This parameter sets the timeout value for a communications failure. The PicoBrick module will sense a communications failure if a valid message is not received from a Host within the specified time period. The timeout time can be set from 0 (disabled) to 6553.5 seconds (109 minutes). When a communications failure is detected, the modules main Status LED ("ST") turns RED and all outputs are forced OFF.

Transmit Enable Lead Delay: This parameter sets the time from when the RS-485 transmitter is enabled to when the first byte of data is sent, forcing a "quiet" period after the transmitter turns ON. Set this value to 0 for most RS-485 networks, as well as for RS-232 operation.

Network Base Address: This parameter sets the base address added to the value in the DIP switches to determine the module's network address.

BrickNet/DF1 Character Gap Timeout: this parameter sets the timeout value for the BrickNet and DF1 character gap. The acceptable range is 0.1 to 2.0 seconds.

RTU Configuration with the I/O Toolbox: Master Mode

Some PicoBrick models can work in a back-to-back "Master" mode. When this feature is used, I/O points on a set of PicoBricks are mirrored. DIs are mapped from the master unit to available DOs on the slave. DIs on the slave unit are mapped to DOs on the master. This feature is disabled by default and must be configured in the ScadaFlexIO Toolbox before use. In addition, the master unit

must have its address set to zero through the address switch located on the front of the unit.

Master Poll Time: This parameter sets the time value for how often the master unit will poll the slave and read/write data. Valid values range from 0 to 6553.5 seconds.

Master Time Out: This parameter sets the time value for how long the master will wait before a message times out and is discarded and either a retry or failure is triggered. Valid values range from 0 to 6553.5 seconds

Master Retries: This parameter sets the number of times the master unit will *retry* a message before going into COM fail mode. Valid values range from 0 to 255.

Modbus Communications

PicoBricks support the Modbus RTU communications protocol. This protocol was originally developed for Modicon Programmable Logic Controllers (PLCs), but now, Modbus is supported by nearly every major HMI/MMI software package, PLC and RTU. PicoBricks can be used in a large number of existing systems and will work without special drivers with many different “Hosts”.

PicoBrick modules support the following four standard Modbus data types:

Data Type	Modbus Type	Description
Status	10xxx	Read Only bits
Coils	00xxx	Read/Write bits
Input Registers	30xxx	Read Only 16-bit values
Holding Registers	40xxx	Read/Write 16-bit values (two combined for 32-bit values)

Note: Do not confuse the Modbus Type with the command codes used to access the various data types.

Both the single and multiple element forms of the Modbus commands that access these data types are supported. For example, there is a command to read or write a single Holding Register, and another command to access a block of Holding Registers. PicoBricks support both command types.

Some values in PicoBricks use 32-bit registers that are accessed as two sequential 16-bit Modbus registers. The Most Significant (high order) portion of the 32-bit value is accessed in the first register, immediately followed by a second register with the Least Significant (low order) portion of the 32-bit value. 32-bit values should always be accessed with the Read or Write multiple registers form of Modbus messages so that both portions of the 32bit value are read together in a single message.

PicoBricks allow up to 128 registers of any type to be accessed in a single message. Be careful to only access valid registers. In general, messages that

access unassigned registers are rejected as invalid messages, unless they are reserved for future use.

Detailed information on the Modbus protocol is available at: **www.modbus.org**

Network Addressing

PicoBricks have a 16-position rotary switch for easy front panel selection of a network address. The actual network address is the switch setting plus a base address saved in EEROM. The default base address is zero, but configuring the base address allows PicoBricks to be set to any of the possible 255 Modbus addresses. In order to simplify setup, PicoBricks always respond to address 255 regardless of the switch and EEROM settings. ***Do not use 255 as an address in a network! Address 0 is not supported.***

Store & Forward

PicoBricks can be used as Remote Terminal Units (RTUs) in radio based systems. To extend the effective range of radio systems, PicoBricks may be configured to digitally repeat messages destined for other PicoBrick or PicoBrick modules that are not directly accessible to the Modbus Master. Although the Modbus standard has no definition for this function, PicoBricks and PicoBricks use a simple form of block address translation to support Store & Forward operation within the Modbus specification framework.

The following “rules” are used for Store and Forward operation:

- The network addresses to be translated and forwarded must be in a single contiguous block.
- The translated addresses must be unique and NOT include the local RTUs address.
- The Master must be capable of ignoring the messages generated with translated addresses (ICL controllers do this automatically). Some Modbus Masters may not like seeing what appears to be a response message with a different address. Since the repeater is by definition “in radio range”, the Master is certain to “see” these messages.

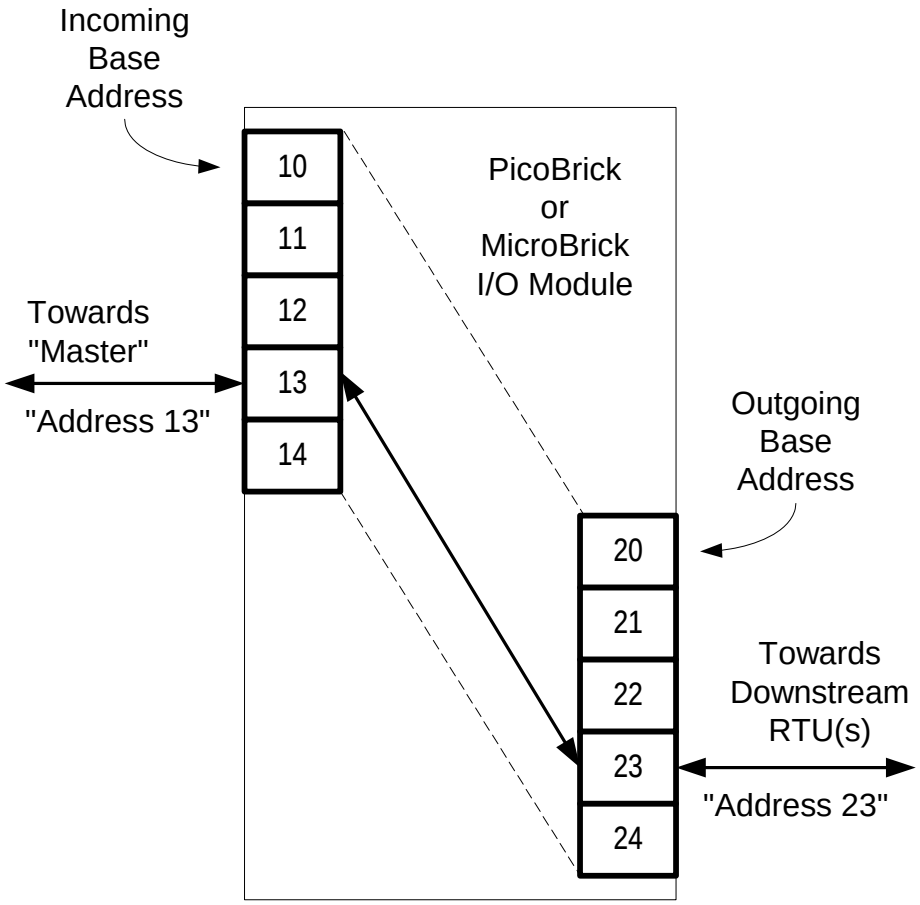
PicoBricks have three holding registers that control the Store and Forward address translation functions; an “Incoming Base Address” register, an “Outgoing Base Address” register, and a “Block Size” register.

When a message is received by a PicoBrick, it first checks to see if the message is intended for itself. If not, it then checks to see if the message falls within the Incoming range of addresses (Incoming Base through Incoming Base + Block Size - 1) or within the Outgoing range of addresses (Outgoing Base through Outgoing Base + Block Size - 1).

If the message falls within the Incoming Range, then the RTU knows that the message came from the Master (or a previous repeater en route from the Master) and it translates the address to the Outgoing Range, calculates a new message CRC check block, and retransmits the modified message. Likewise, if the message falls within the Outgoing Range, then the RTU knows that the message came from a downstream RTU (or a previous repeater) and it translates the address to the Incoming Range, calculates a new message CRC check block, and retransmits the modified message back towards the Master.

There is no limit to the number of repeater hops that can be used other then the total number of available addresses (255).

The Store and Forward translation process is pictured below.



Modbus Message Store and Forward Address Translation

In this example, the Incoming Base Address is set to “10”, the Outgoing Base Address is set to “20”, and the Block Size is set to “5”.

A message that comes from the direction of the Master with an address of “13” is translated to an address of “23’ and rebroadcast. Likewise, when the downstream unit responds, the message will come from address “23” and be

translated and rebroadcast as address “13”. As far as the Modbus Master is concerned, it is communicating with address “13”, but with some additional delay caused by the repeating process.

The incoming address range, once setup, those addresses are reserved from the 254 available addresses on a Modbus system. There can be no “real” nodes on the network that respond to any of the incoming addresses in the incoming block.

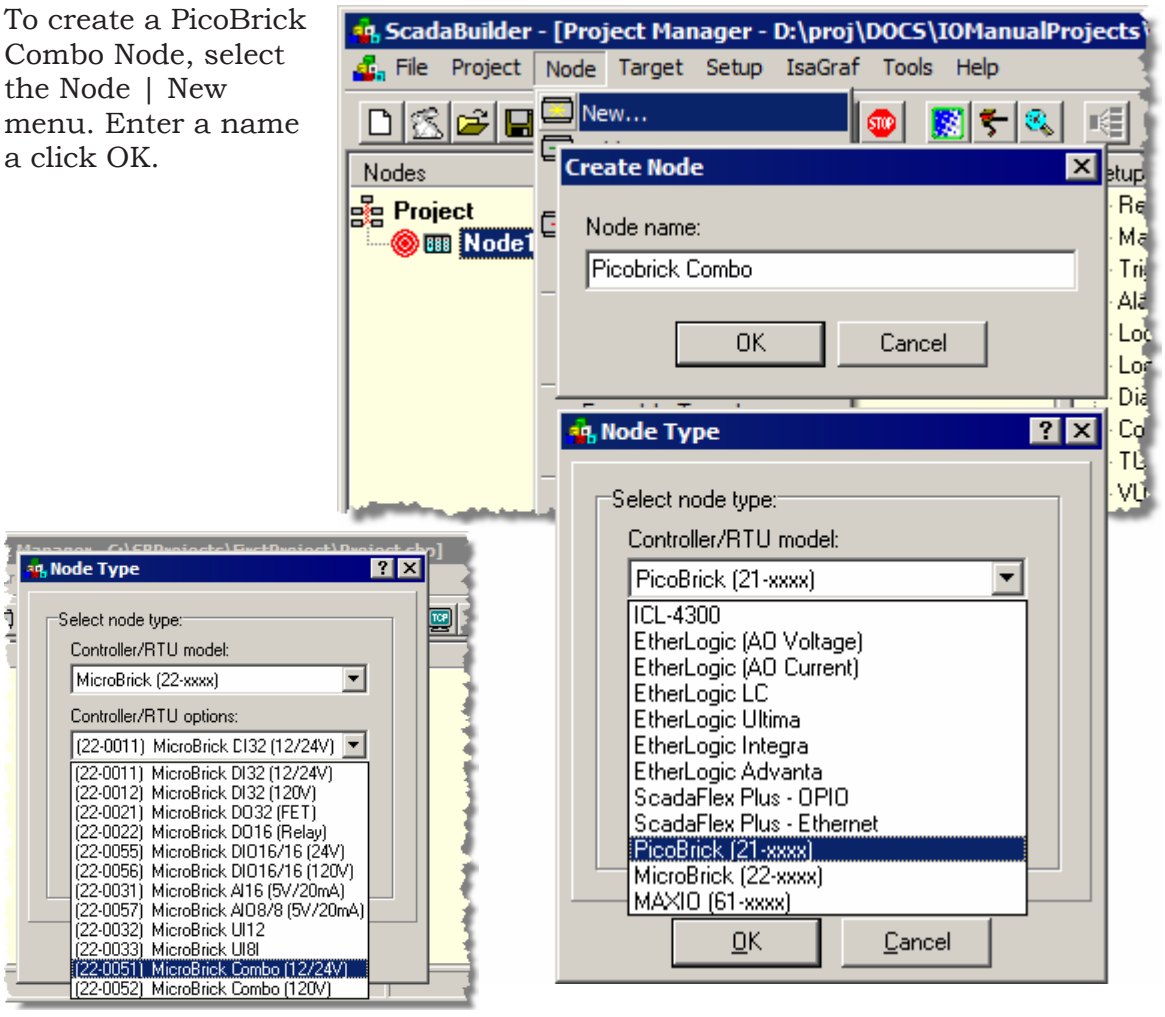
Using an address for a “real” node that is used in an incoming block will cause a collision as the repeater and the addressed node will try to send out a message at the same time.

BrickNet Communications

All I/O Expansion modules available from ICL talk ICL's BrickNet Protocol. ScadaBuilder (ICL's controller programming software) is aware of the register map of every I/O module and can access those registers directly by name and block.

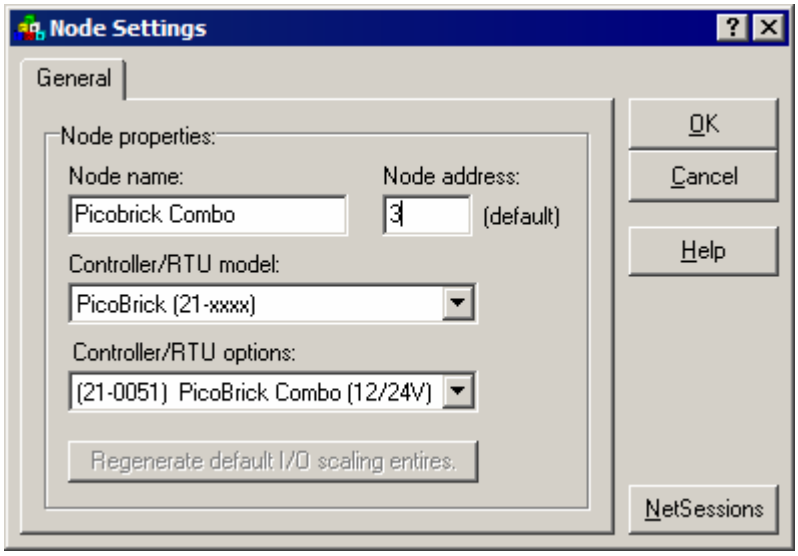
To utilize this feature, you first have to create a new Node in the ScadaBuilder project where you want to use the I/O module. We will use a PicoBrick Combo module for this exercise but the concepts are the same for all other *PicoBricks, PicoBricks, MAXIO's and ScadaFlex RTU's.*

To create a PicoBrick Combo Node, select the Node | New menu. Enter a name a click OK.

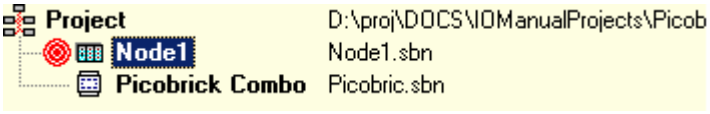


Select the PicoBrick type (or whatever your device might be by model number).

Enter a Node address that is something other than what you main controller's address is going to be. See Creating a BrickNet Session in the ScadaWorks Technical Reference Manual for details.



You should have a project that looks like the following:



Create a Network Port

See Creating a Network Port in the ScadaWorks Technical Reference manual. Make sure the baudrate matches the Picobrick's configuration and is set to 8 databits, no parity and 1 stopbit. If using RS-485, select the 485 Default button in the Network Port dialog

Create a BrickNet Network Session.

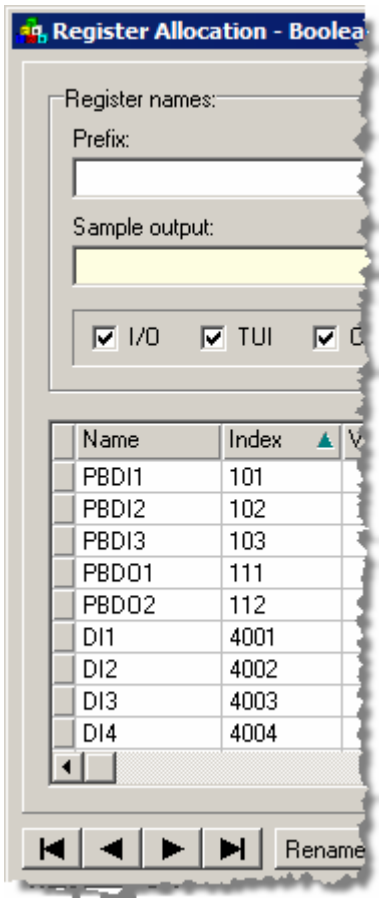
See Creating a Bricknet Session in the ScadaWorks Technical Reference Manual for details. Configure it for an address different that any other I/O modules or controllers on this Bricknet network. Select the port you wish to use for your network.

Registers For Retrieving Data.

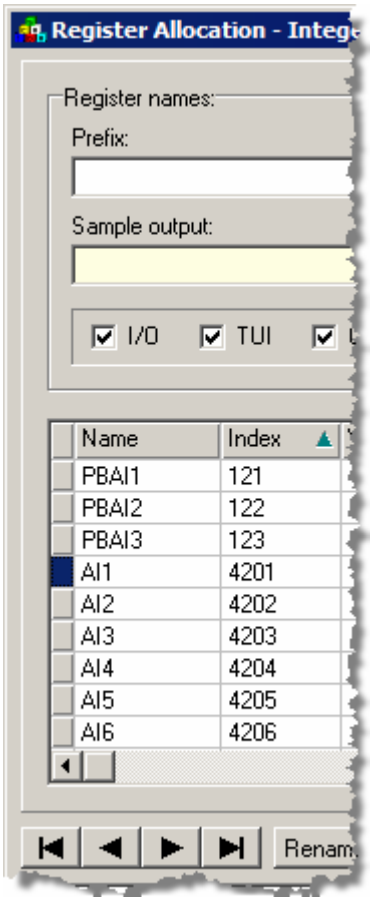
You must create registers to store locally the I/O points of the combo module. Declare the following points in the Registers section of the Setup window of ScadaBuilder. See the Registers section of the ScadaWorks Technical Reference Manual for details.

Create the following registers to store the values into:

Booleans	Booleans	Integers
PBDI1 101	PBDO1 111	PBAI1 121
PBDI2 102	PBDO2 112	PBAI2 122
PBDI3 103		PBAI3 123



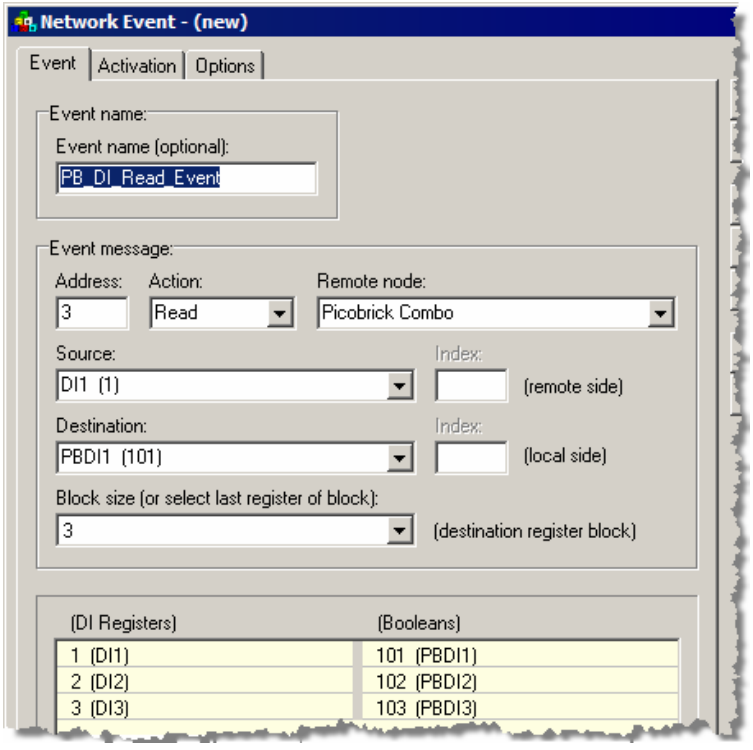
Your Boolean register list should look like the list on the left.



And your integer register list should look like the list on the right

Next we need to create the Network Events.

Click on the Events button in the lower right hand corner of the BrickNet Network Session you created above. This will give you the Network Event List. Click on the New button to get the following dialog. See Creating BrickNet Network Events in the ScadaWorks Technical Reference Manual for more details.

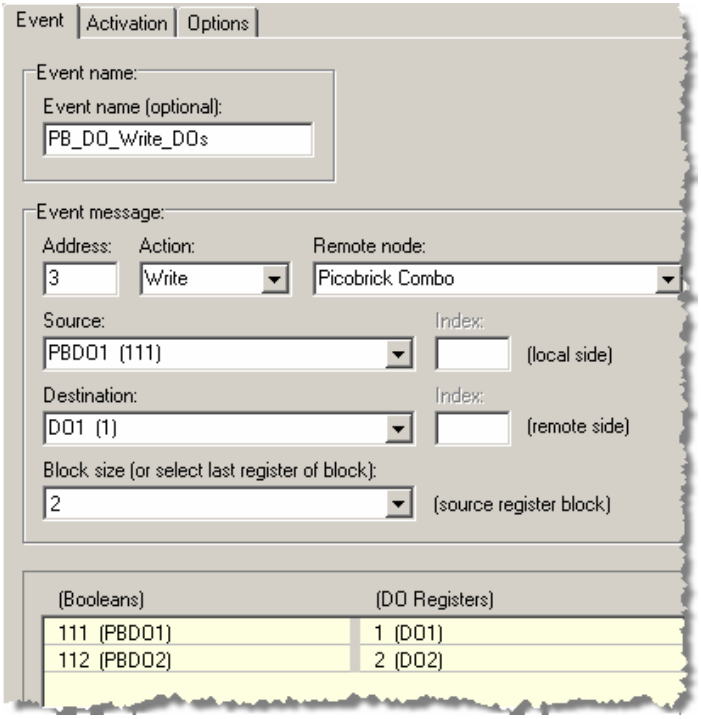


- Name the Event (we will be reading the DI's from the PB Combo.
- Select the Action (Read),
- Select the Remote Node (which is the Module you setup).
- Select the Destination (this tells ScadaBuilder what data type you are going to use.
- Select the source of the first DI register of

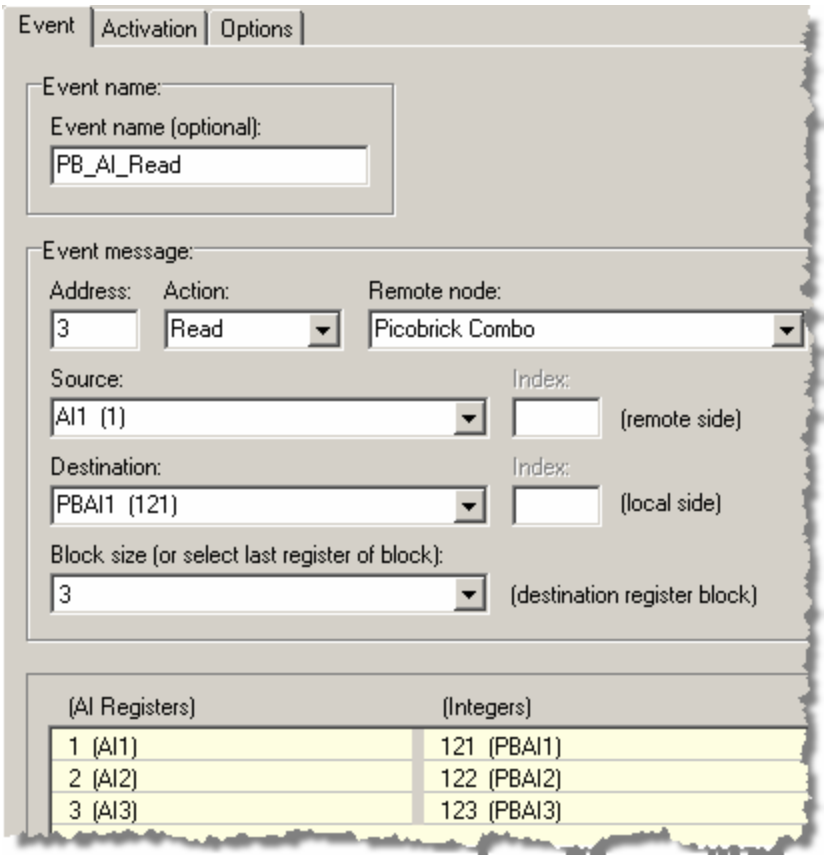
the PicoBrick.

- Enter the block size to get all 3 DI's.
- Click on the Activation tab, Enter Cyclic and 1 and click the Add button

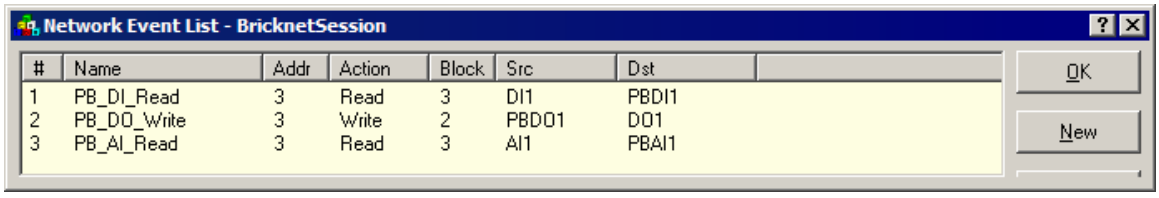
To write to the Digital Outputs of the PicoBrick Combo Module, enter the following with the same Cyclic 1 Activation:



Reading the Analog Inputs on the PicoBrick is the same as reading the DI's only a different data type:



You should now have a Network Event List like the following:



Setup Complete. Connect your I/O module to the port defined, make sure the Slave number and baud rate are correct and download the application to the controller. Consult your hardware manual for the appropriate cabling to connect your I/O module.

Different products have different I/O based on the model number and type. Interfacing to all of them is similar to what is shown here.

DF1 Communications

Due the installed base of Allen-Bradley programmable logic controllers and the high cost of protocol adapter modules, the DF1 protocol is a popular means of interfacing these PLCs with ICL controllers. In the DF1 protocol, a single Master communicates with up to 254 slaves. Slaves do not send messages on their own; they respond to messages from the Master. DF1 is designed to operate over serial networks; RS-232 for short point-to-point connections, RS-485 for longer distance hard-wired networks, and radios and modems for even longer distances. DF1 can support three types of data; bits, integers and floating point numbers. DF1 over Ethernet is not supported at this time.

PicoBrick units can communicate using Allen-Bradley's DF1 protocol using the DH-485 transport layer. This protocol allows the RTU to respond to messages that are sent from a DF1 master device. These messages can read and write information stored in registers.

Data Type	DF1 Type	Description
Digital Input	B3	Read Only bits
Digital Output	N13	Read/Write bits
Analog Input	B7	Read Only 16-bit values
Analog Output	N17	Read/Write 16-bit values

Note: 32-bit registers are not currently supported in ICL's RTU implementation of DF1.

Note: ScadaWorks users will not use the 'N' character when setting up r/w DF1 events. Instead they will select the 'Number' option from the 'Source' dropdown in the network event configuration window and enter in either '13' or '17.'

ICL RTUs support the serial, half-duplex version of DF1with CRC error checking. BCC error checking in RTU units is not supported at this time

Maintenance

PicoBricks are designed for long-term maintenance-free operation. The only maintenance item is periodic calibration of the Analog and Combo PicoBricks, and possible firmware updates.

Analog Calibration

Industry standard practice typically recommends checking the calibration of analog measurement devices once a year. The calibration values for PicoBricks with analog inputs are retained in nonvolatile EEROM memory, and may be viewed and changed using a ScadaFlex I/O Toolbox program available from Industrial Control Links. Please contact technical support for a copy, along with the recommended field calibration procedures. A backup copy of all calibration values, as determined by an automated test system in the factory, is always retained separately in another area of nonvolatile memory, “just in case”. The same toolbox software can restore the factory calibration values if needed.

Firmware Updates

The internal PicoBrick microprocessor firmware is easily and quickly updated using a Bootloader Windows program. With the program running on a PC or laptop computer plugged into the PicoBricks RS-232 port, and a path to the new firmware selected, the PicoBrick microprocessor firmware will be updated by simply cycling power for the PicoBrick when prompted. The PicoBricks Status LED flashes GREEN for a couple of seconds when powered ON, indicating that it is looking to “connect” with the bootloader software application on a PC computer. If a bootload operation is not initiated in that window of time, the PicoBrick begins normal operation.

Mechanical Installation

ICL I/O Modules are designed to be installed in a protective enclosure with the appropriate NEMA rating for the environment that the controller will be used. Typical NEMA ratings are as follows:

North America:

Indoor applications only: NEMA 1 Indoor or Outdoor applications: NEMA 4, 4X or 12 rated enclosures.

European Union:

Must be installed inside IP54 or IP56 rated enclosures.

Transient suppression must be supplied externally for each active signal for the following circuits:

Signal(s)	*Maximum Operating Voltage*	*140% Transient Suppression Level.*	*Circuit Connection*
Digital Inputs 5 through 12 120 VAC RMS/DC	300V	420VAC RMS or 420VDC	DI to DI Common
Digital Inputs 5 through 12 12/24V AC DC	50V	70VAC RMS or 70VDC	DI to DI Common
RS 232 Signals (DTR, CD, RTS, CTS, RX, and TX) *	+/-12VDC	+/- 16.8VDC	Signal to RS 232 Common

The enclosure material must be a minimum of 1.14mm (0.045") thick. Typically, the controller is mounted vertically in such an enclosure on a steel backplate. If an alternative mounting scheme is used, it is recommended that the controller be mounted on a noncombustible surface.

External surge suppression must be installed to limit all operating voltages to within 140% of signal voltage. This includes all RS-232 signals, Digital Input, and Pulse Input terminals.

CAUTION: If the module is mounted on or above a combustible surface (such as a wood backboard), a plate of at least 1.43mm (0.056") galvanized or 1.6mm (0.063") uncoated steel extending at least 150mm (5.9") beyond the controller on all sides must be installed.

Electrical Installation

All field wiring connections to and from the I/O module, are made via removable terminal blocks.

Class 1 Division 2 Group A, B, C, and D Requirements

THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS A, B, C, D OR NON-HAZARDOUS LOCATIONS ONLY.

WARNING - EXPLOSION HAZARD – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2;

AVERTISSEMENT - RISQUE D'EXPLOSION – LA SUBSTITUTION DECOMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2;

WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS;

AVERTISSEMENT - RISQUE D'EXPLOSION - AVANT DE DÉCONNECTER L'EQUIPEMENT, COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX.

WARNING - DO NOT REMOVE OR REPLACE ANY CONNECTORS OR FUSES OR OPERATE DIP SWITCHES WHILE CIRCUITS ARE LIVE UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITABLE CONCENTRATIONS OF FLAMMABLE GASSES OR VAPORS.

AVERTISSEMENT - RISQUE D'EXPLOSION - COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX AVANT DE REPLACER LE COMPOSANTS

NOTE: The terminal block screws must be tightened to 7 lb-in.

Diagrams in the following sections provide examples for analog and discrete I/O and power wiring. The following wiring guidelines must be followed:

Stranded conductors from #14 to #26 AWG, or solid conductors from #12 to #26AWG consisting of either copper or copper-clad aluminum is permitted.

Wires must be rated for 240V, 90ºC and suitably current rated.

Wire insulation must be a minimum of 0.9mm (0.031") thick if subjected to movement, flexing or handling during use or maintenance.

Wires shall be routed away from sharp edges, screw threads, burrs, fins, moving parts, drawers, and the like.

Clamps and guides, if used, shall be provided with smooth, well-rounded edges.

Wiring that is subject to flexing during servicing such as that from a stationary part to a part mounted on a hinged door shall be provided with additional insulation at any point where flexed.

Additional insulation, if used, shall be insulating tubing, or a wrapping of not less than two layers of insulating tape. All must be minimum of 90ºC and 240V.

All splices and connections must be mechanically secure and provide electrical continuity

Conductors are also not to be grouped.

CAUTION: Use supply wires suitable for 15ºC above surrounding ambient

ATTENTION: Utiliser des fils d'alimentation qui conviennent a une temperature de 15ºC au-dessus de la temperature ambiente.

Discrete Input Modules

PicoBrick Discrete Input modules are used to monitor the state of switches, relays contacts, motor starter auxiliary contacts and any other on/off type sensor signal. The inputs are optically isolated to avoid ground loop effects and prevent damage from transients and power surges on the input lines. There are a total of 12 discrete inputs built into PicoBrick DI12 modules.

Signal Types and Levels

PicoBrick Discrete Input modules have a unique input design that accepts both AC and DC signals. The inputs are not sensitive to signal polarity, supporting DC sensors with either “sinking” or “sourcing” output configurations as well as switch contacts with AC or DC signals.

Currently, there are two models of PicoBrick Discrete Input Modules; one designed for low-voltage (12/24V) operation, the other for 120V operation.

In the low voltage model, an input level of 9 volts (AC/DC) or greater is considered to be an “ON”. Input levels of 6 volts (AC/DC) or less are considered OFF. The inputs can accept signal levels of up to 50 volts (AC/DC) and tolerate overloads of nearly twice that.

The 120V model responds to inputs of 75V or greater as an “ON”, 50V or less as an “OFF” and will tolerate a 100% overload.

Other input voltage ranges are available by special order. Please contact your ICL representative for additional information.

LED Input Status Indicators

Each discrete input has an LED indicator to show the current ON or OFF state of the input.

I/O Processor Functions

The discrete inputs are supported by an intelligent I/O microprocessor that performs processing that goes beyond monitoring the simple on or off state of inputs. These tasks include input noise filtering, pulse counting, runtime totalization, and pulse rate computation. These local functions help off-load the Host Controller and improve system performance.

Input Filtering

The discrete inputs have filtering that rejects spurious noise and limits the maximum counting rate to 40Hz with DC pulses, up to 10Hz with AC signals.

Pulse Totalization

PicoBrick Discrete Input modules count ON transitions for every input point, providing reliable pulse totalization that is not sensitive to communications rates and I/O scan time. This feature can be used for very accurate flow and wattage totalization.

The pulse totalizers are 32-bit counters, meaning that the totalizers count up to 4,294,836,225 ON transitions before they “roll over” to zero again. The counters can be reset to zero, or any preset value, at any time.

Runtime Totalization

PicoBrick Discrete Input modules monitor the runtime (ON time) for every input point, providing reliable “down-to-the-second” measurement of how long an input has been “ON”. This information is useful for scheduling equipment maintenance and wear leveling. For example, to maximize pump life in a multi-pump system, runtime can be used to determine which pump should be used next based on which pump has seen the least usage to date.

The runtime totalizers are 32-bit registers, and count seconds up to 4,294,836,225 before they “roll over” to zero again. The runtime totalizers can be reset to zero or preset to a value at any time by simply writing to the individual totalizer register(s).

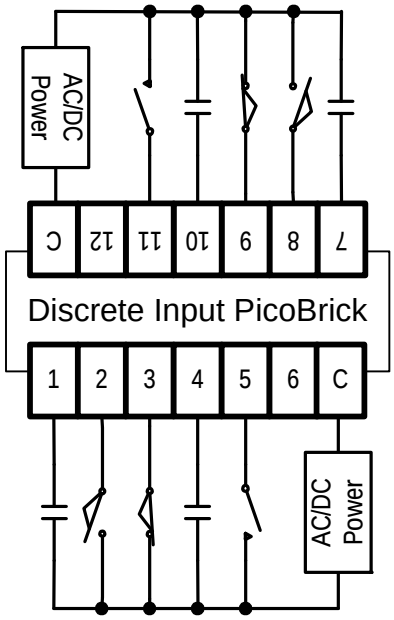
Pulse Rate Calculation

PicoBrick Discrete Input modules calculate the input pulse rate for every input. With the appropriate sensors, this can be used to show “real-time” flow, usage rates, and speeds. A software settable “gate” time determines the measurement interval over which the input pulses are counted. Longer gate time intervals provide greater measurement resolution, but the measured value is updated less frequently. The gate time is the measurement update interval. Once the gate time has expired, each totalized count is stored in a rate register for that discrete input, and a new set of rate totalization measurements are automatically started.

Field Wiring

The Discrete Input signals from field sensors come into the PicoBrick on a pair of 7-position removable terminal blocks. Each block has 6 inputs plus a common that is shared by those 6 inputs, but isolated from the other 7 position, 6-input terminal block.

The discrete inputs are passive and require an active voltage to be switched between their common and the input signal connections. The inputs are isolated so that power source for the inputs can safely be the PicoBricks own power supply without causing a ground loop. The inputs are not sensitive to polarity, so the power lead connected to the field sensors can be either the negative or positive side of a DC power source, or AC power can be used. The input current at 12Vdc is approximately 1mA, sufficient for contact “wetting”, but low enough for practical use in solar and battery-backed applications.



Discrete Input PicoBricks - Field Wiring Example

Modbus Register Map

PicoBrick Discrete Input modules use the following Modbus register map:

STATUS (Read Only Input Bits - Modbus Type 10xxx)

Start	*End*	*Description*
001	012	Discrete Inputs 1 through 12

COILS (Read/Write Output Bits - Modbus Type 00xxx)

none

INPUT REGISTERS (Read Only 16-bit - Modbus Type 30xxx)

Start	*End*	*Description*
001	012	Pulse Rate - Inputs 1 through 12
248	249	Reserved - ICL Test ONLY
250	-	Input Voltage (power) x 10 (143 = 14.3 volts)
251	254	Reserved - ICL Test ONLY
255	-	Firmware Revision
256	-	Device ID (DI12-24 = 2111, DI12-120 = 2112)

HOLDING REGISTERS (Read/Write 16-bit - Modbus Type 40xxx)

Star	*End*	*Description*
001	024	Pulse Totalizers - Inputs 1 through 12 (32-bit, 1st/Odd register is MSB)
025	048	Runtime Totalizers - Inputs 1 through 12 (32-bit, 1st/Odd register is MSB)
129	-	Rate Measurement “Gate” (sampling) Time
149	-	Input Power (voltage) calibration numerator (denominator = 65,535)
245	-	Store & Forward - Incoming Base Address
246	-	Store & Forward - Outgoing (remapped) Base Address
247	-	Store & Forward - Address Range (block size)
248	-	Communications Watchdog Timer (10mS increments)
249	-	Xmit Enable Delay (Xmit Enable to Xmit Data in 10mS increments)
253	-	Baud Rate Index (0 = 2400, 1 = 4800, 2 = 9600, 3 = 19200, 4 = 38400, 5 = 115200)
254	-	Status Register (0001h = restarted, 0002h = comm. timed out)
255	-	Reserved - Test Register - ICL Test ONLY
256	-	Reserved - Control Register - ICL Test ONLY

Specifications - Discrete Input PicoBricks

DISCRETE INPUT Module - Model# 21-0011 (DI12-24)

Number of Discrete Inputs	12
Input Type	Bipolar Optocoupler
Input Voltage, nominal	12/24 Vdc/ac
Input Voltage Range	0 to 60 Vdc/ac
Input Overvoltage Tolerance	85Vdc/Vac
Input Resistance, typical	10,000 ohms
Input Noise Filtering, AC/DC	20Hz / 100Hz
Counting Frequency, AC/DC	10Hz / 50Hz

DISCRETE INPUT Module - Model# 21-0012 (DI12-120)

Number of Discrete Inputs	12
Input Type	Bipolar Optocoupler
Input Voltage, nominal	120 Vdc/ac
Input Voltage Range	0 to 125 Vdc/ac
Input Overvoltage Tolerance	190Vdc/Vac
Input Resistance, typical	100,000 ohms
Input Noise Filtering, AC/DC	20Hz / 100Hz
Counting Frequency, AC/DC	10Hz / 50Hz

COMMUNICATIONS (all models)

Serial Ports	1
Serial Port Interfaces	RS-232 and RS-485
Data Rate	2400 baud to 115K baud
Communications Protocol	Modbus RTU

ENVIRONMENTAL SPECIFICATIONS (all models)

Dimensions	1.38” W x 4.60” L x 2.85” (35mm x 117mm x 72mm)
D	
Power (Input Voltage Range)	10 to 28Vdc
Power, Typical/Maximum	30mA / 35mA
Temperature, operating	-40°C to 75°C (-40°F to 167°F)
Temperature, storage	-40°C to 100°C (-40°F to 212°F)
Isolation, Field to Logic	2000 volts
Humidity	5 to 85% RH, (non-condensing)
Wiring Terminations	Removable Terminal Blocks
Wire Size	#14 to #26 stranded, #12 solid

Discrete Output Module

PicoBrick Discrete Output modules are used to control relays, lights, motor starters, annunciators or any other on/off type control device.

The PicoBrick Discrete Output module has 12 solid state FET (protected transistor) outputs. Unlike mechanical relays, FET transistors are extremely efficient and consume very little power, ideal for solar and battery backed systems. When a “dry” relay contact is required, the FET outputs can drive interposing relays.

The FET outputs are isolated as well as overload, surge, and reverse polarity protected by a combination of self-resetting polymer fuses and “Transorb” transient limiters. Because of the built-in transient protection, a suppression diode is typically not required across relay coils or other inductive loads driven by the PicoBrick discrete outputs.

The FET outputs are designed to operate in 12 and 24 volt control systems, with control voltages of up to 28 volts DC. An external power source is NOT required to power the PicoBrick FET output circuitry, but IS required by the load devices. FET outputs ARE sensitive to signal polarity, driving DC control devices with an open drain output that switches to a common “ground”. When turned ON, the outputs have a very low (< 2Ω) resistance to the common. When turned OFF, the outputs exhibit very high resistance and low leakage that will not provide a false ON to sensitive controller inputs like other solid state outputs have in the past. If an output drives a low resistance or shorted load, it will be protected automatically, switching to a low current, high-resistance state. The output will continue to sink some current in this condition until the overload is removed. Once the fault condition is cleared, the output will automatically switch back to its normal low resistance state, driving the full current required by the load.

LED Output Status Indicators

Each discrete output has an LED indicator to show the current ON or OFF state of the output.

I/O Processor Functions

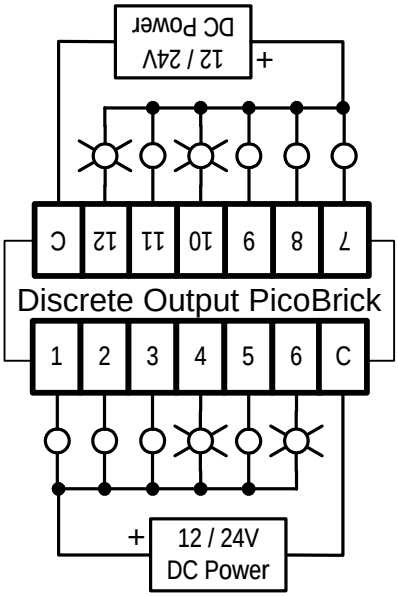
PicoBrick Discrete Output Modules are sometimes used to flash alarm indicators. Without help from the on-board microprocessor, variations in communications and I/O scan time can make the flashing look erratic. Each of the PicoBrick discrete outputs has a precise flashing capability that is independent of communications I/O speed or scan time. Two control bits are used per output; one to turn the output ON or OFF, the second to command the output to flash whenever it is turned ON by the first bit. A separate register sets the flashing rate.

Field Wiring

PicoBrick Discrete Output modules connect to their field wiring via a pair of 7-position removable terminal blocks. There are 6 outputs on either side of the module. The outputs on one terminal block share a common, but are isolated from the other 6 outputs and their common.

The PicoBrick Discrete Outputs are passive and require an active positive supply voltage on one side of the load, while the output from the PicoBrick switches the other side of the load to the power return. The return must be the negative side of the power source.

Examples of field wiring for the discrete output module are shown below.



PicoBrick Discrete Outputs - Field Wiring Example

Modbus Register Map

PicoBrick Discrete Output modules use the following Modbus register map:

STATUS (Read Only Input Bits - Modbus Type 10xxx)

none

COILS (Read/Write Output Bits - Modbus Type 00xxx)

Start	*End*	*Description*
001	012	Discrete Outputs 1 through 12
033	044	Flash Enables 1 through 12

INPUT REGISTERS (Read Only 16-bit - Modbus Type 30xxx)

Start	*End*	*Description*
248	249	Reserved - ICL Test ONLY
250	-	Input Voltage (power) x 10 (143 = 14.3 volts)
251	254	Reserved - ICL Test ONLY
255	-	Firmware Revision
256	-	Device ID (DO12-24 = 2121)

HOLDING REGISTERS (Read/Write 16-bit - Modbus Type 40xxx)

Start	*End*	*Description*
131	-	Output Flash Rate ON/OFF time (half duty cycle) in 10mS. increments
149	-	Input Power (voltage) calibration numerator (denominator = 65,535)
245	-	Store & Forward - Incoming Base Address
246	-	Store & Forward - Outgoing (remapped) Base Address
247	-	Store & Forward - Address Range (block size)
248	-	Communications Watchdog Timer (10mS increments)
249	-	Xmit Enable Delay (Xmit Enable to Xmit Data in 10mS increments)
253	-	Baud Rate Index (0 = 2400, 1 = 4800, 2 = 9600, 3 = 19200, 4 = 38400, 5 = 115200)
254	-	Status Register (0001h = restarted, 0002h = comm. timed out)
255	-	Reserved - Test Register - ICL Test ONLY
256	-	Reserved - Control Register - ICL Test ONLY

Specifications - Discrete Output PicoBrick

FET DISCRETE OUTPUT Module - Model# 21-0021 (DO12-24)

Number of Discrete Outputs	12
Output Type	FET Power Transistor
Output Configuration	Sinking to Common (open drain)
Output Voltage, nominal	12/24Vdc
Output Voltage Range	0 to 28Vdc
Output Switch Rating	0.5A @ 20oC, derate linearly to 0.25A @ 80oC 3.0A peak (0.5 second surge)
Overvoltage & Transient Protection	Transorb
Overload Protection	Self Resetting Polymer Fuse
Flash ON/OFF times & Resolution	0 to 655.35 seconds in 10mS increments

COMMUNICATIONS (all models)

Serial Ports	1
Serial Port Interfaces	RS-232 and RS-485
Data Rate	2400 baud to 115K baud
Communications Protocol	Modbus RTU

ENVIRONMENTAL SPECIFICATIONS (all models)

Dimensions	1.38" W x 4.60" L x 2.85" D (35mm x 117mm x 72mm)
Power (Input Voltage Range)	10 to 28Vdc
Power, Typical/Maximum	30mA / 35mA
Temperature, operating	-40°C to 75°C (-40°F to 167°F)
Temperature, storage	-40°C to 100°C (-40°F to 212°F)
Isolation, Field to Logic	2000 volts
Humidity	5 to 85% RH, (non-condensing)
Wiring Terminations	Removable Terminal Blocks
Wire Size	#14 to #26 stranded, #12 solid

Discrete I/O Modules

PicoBrick Discrete I/O modules provide a mix of discrete inputs, and discrete outputs. They are an economical alternative to using separate modules when smaller quantities of I/O are needed. Because of their mix of I/O, Discrete I/O PicoBricks are frequently used as low-cost Modbus Remote Terminal Units (RTUs).

Discrete I/O PicoBricks have 6 Discrete Inputs (12/24V or 120V models), and 6 discrete (FET) outputs. The functionality of each section is identical to their equivalent PicoBrick modules

Discrete I/O Module Discrete Input Section

Discrete I/O module Discrete Inputs are used to monitor the state of switches, relays contacts, motor starter auxiliary contacts and any other on/off type sensor signal. The inputs are optically isolated to avoid ground loop effects and damage from transients and power surges. There are a total of 3 discrete inputs with a shared common.

Signal Types and Levels

The Discrete I/O module Discrete Inputs have a unique input design that accepts both AC and DC signals. The inputs are not sensitive to signal polarity, supporting DC sensors with either “sinking” or “sourcing” output configurations as well as switch contacts with AC or DC signals.

Currently, there are two models of Discrete I/O Modules; one designed for low-voltage (12/24V) discrete inputs, the other for 120V discrete inputs. In the low voltage model, an input level of 9 volts (AC/DC) or greater is considered to be an “ON”. Input levels of 6 volts (AC/DC) or less are considered OFF. The inputs can accept signal levels of up to 50 volts (AC/DC) and tolerate overloads of nearly twice that. The 120V model responds to inputs of 75V or greater as an “ON”, 50V or less as an “OFF” and will tolerate a 100% overload.

LED Input Status Indicators

Each discrete input has an LED indicator to show the current ON or OFF state of the input.

I/O Processor Functions

The discrete inputs are supported by a microprocessor that performs input noise filtering, pulse totalization and pulse rate computation, helping to off-load the Host Controller and improve system performance.

Input Filtering

The discrete inputs have filtering that rejects spurious noise and limits the maximum counting rate to 40Hz with DC pulses, up to 10Hz with AC signals.

Pulse Totalization

Discrete I/O module Discrete Inputs count ON transitions for every input point, providing reliable pulse totalization that is not sensitive to communications rates and I/O scan time. This feature can be used for very accurate flow and wattage totalization.

The pulse totalizers are 32-bit counters, meaning that the totalizers count up to 4,294,836,225 ON transitions before they “roll over” to zero again. The counters can be reset or preset to any value at any time.

Runtime Totalization

PicoBrick Combo module Discrete Inputs monitor the runtime (ON time) for every input, providing reliable “down-to-the-second” information on how long an input has been “ON”. This information is useful for equipment maintenance and wear leveling. An example is the use of runtime to determine which pump should be used based on which pump has seen the least usage.

The runtime totalizers are 32-bit registers, meaning that the totalizers count seconds, up to 4,294,836,225 before they “roll over” to zero again. The runtime totalizers can be reset to zero or preset to a value at any time by simply writing to the appropriate register.

Pulse Rate Calculation

PicoBrick Combo module Discrete Inputs calculate the input pulse rate for every input. With the appropriate sensors, this can be used to show “real-time” flow, usage rates, and speeds. A software settable “gate” time determines the measurement interval over which the input pulses are counted. Longer gate time intervals provide greater measurement resolution, but the measured value is updated less frequently. The gate time is the measurement update interval. Once the gate time has expired, each totalized count is stored in a Modbus register for that discrete input, and a new set of rate totalization measurements are started.

Discrete I/O Module Discrete Output Section

Discrete I/O module Discrete Outputs are used to control relays, motor starters, lights, annunciators and any other on/off type control device. The Combo modules provide 2 solid state FET (protected transistor) outputs. FET transistors are extremely efficient and consume very little power, ideal for solar and battery backed systems. If a “dry” relay contact is required, a FET output can drive an interposing relay.

The FET outputs are isolated as well as overload, surge, and reverse polarity protected by self-resetting polymer fuses and “Transorb” transient limiters. Because of the built-in transient protection, a suppression diode is typically not required across relay coils or other inductive loads.

The FET outputs are designed to operate in 12 and 24 volt control systems, with control voltages of up to 28 volts DC. An external power source is NOT required to power the PicoBrick FET output circuitry, but IS required by the load devices. FET outputs ARE sensitive to signal polarity, driving DC control devices with an open drain output that switches to a common “ground”. When turned ON, the outputs have a very low (< 2Ω) resistance to the common. When turned OFF, the outputs exhibit very high resistance and low leakage that will not provide a false ON to sensitive controller inputs like other solid state outputs have in the past. If an output drives a low resistance or shorted load, it will be protected automatically by switching to a low current state high resistance state. The output will continue to sink some current in this condition until the overload is removed. Once the fault condition is cleared, the output will automatically switch back to its normal low resistance, driving the full current required by the load.

LED Output Status Indicators

Each discrete output has an LED indicator to show the current ON or OFF state of the output.

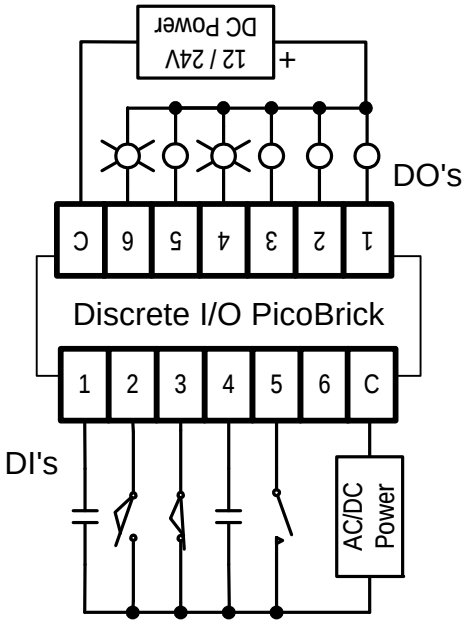
I/O Processor Functions - Discrete Outputs

PicoBricks are sometimes used to flash alarm indicators remotely, but without help from the on-board microprocessor, variations in communications and I/O scan time can make the flashing look erratic. All of the PicoBrick Discrete I/O Module discrete outputs have a precise flashing capability that is independent of communications I/O speed or scan time. Six control bits are used per output; one to turn the output ON or OFF, the second to command the output to flash whenever it is turned ON by the first bit. A separate Modbus register sets the flashing rate.

Discrete I/O Module Field Wiring

Discrete I/O Module discrete I/O field wiring terminates at two 7-position removable terminal blocks with one isolated common.

The Discrete Outputs are “open-drain” FET transistors that require a positive supply voltage on one side of the loads, while the outputs switch the other side of the loads to the power return. The power return must be connected to the negative side of the power source.



The Discrete Inputs require an active voltage to be switched between their common and the input signal connections. The inputs are isolated, so the power source for the inputs can be the PicoBricks power supply without causing a ground loop. The discrete inputs are not sensitive to polarity. The input current at 12Vdc is approximately 1mA, sufficient for contact “wetting”, but low enough for use in solar and battery-backed applications.

Modbus Register Map

PicoBrick Discrete Input modules use the following Modbus register map:

STATUS (Read Only Input Bits - Modbus Type 10xxx)

Start	*End*	*Description*
001	006	Discrete Inputs 1 through 6

COILS (Read/Write Output Bits - Modbus Type 00xxx)

Start	*End*	*Description*
001	006	Discrete Outputs 1 through 6
033	038	Flash Enables 1 through 6

INPUT REGISTERS (Read Only 16-bit - Modbus Type 30xxx)

Start	*End*	*Description*
001	006	Pulse Rate - Inputs 1 through 6
248	249	Reserved - ICL Test ONLY
250	-	Input Voltage (power) x 10 (143 = 14.3 volts)
251	254	Reserved - ICL Test ONLY
255	-	Firmware Revision
256	-	Device ID (DIO12-24 = 2155, DI O12-120 = 2156)

HOLDING REGISTERS (Read/Write 16-bit - Modbus Type 40xxx)

Star	*End*	*Description*
001	012	Pulse Totalizers - Inputs 1 through 6 (32-bit, 1st/Odd register is MSB)
013	024	Runtime Totalizers - Inputs 1 through 6 (32-bit, 1st/Odd register is MSB)
129	-	Rate Measurement “Gate” (sampling) Time
131	-	Output Flash Rate ON/OFF time (half duty cycle) in 10mS. increments
149	-	Input Power (voltage) calibration numerator (denominator = 65,535)
245	-	Store & Forward - Incoming Base Address
246	-	Store & Forward - Outgoing (remapped) Base Address
247	-	Store & Forward - Address Range (block size)
248	-	Communications Watchdog Timer (10mS increments)
249	-	Xmit Enable Delay (Xmit Enable to Xmit Data in 10mS increments)
253	-	Baud Rate Index (0 = 2400, 1 = 4800, 2 = 9600, 3 = 19200, 4 = 38400, 5 = 115200)
254	-	Status Register (0001h = restarted, 0002h = comm. timed out)
255	-	Reserved - Test Register - ICL Test ONLY
256	-	Reserved - Control Register - ICL Test ONLY

Specifications - Discrete Input PicoBricks

DISCRETE INPUTS Module - Model# 21-0055 (DIO6/6-24)

Number of Discrete Inputs	6
Input Type	Bipolar Optocoupler
Input Voltage, nominal	12/24 Vdc/ac
Input Voltage Range	0 to 60 Vdc/ac
Input Overvoltage Tolerance	85Vdc/Vac
Input Resistance, typical	10,000 ohms
Input Noise Filtering, AC/DC	20Hz / 100Hz
Counting Frequency, AC/DC	10Hz / 50Hz

DISCRETE INPUTS Module - Model# 21-0056 (DIO6/6-120)

Number of Discrete Inputs	6
Input Type	Bipolar Optocoupler
Input Voltage, nominal	120 Vdc/ac
Input Voltage Range	0 to 125 Vdc/ac
Input Overvoltage Tolerance	190Vdc/Vac
Input Resistance, typical	100,000 ohms
Input Noise Filtering, AC/DC	20Hz / 100Hz
Counting Frequency, AC/DC	10Hz / 50Hz

FET DISCRETE OUTPUTS All DIO6/6 Modules

Number of Discrete Outputs	6
Output Type	FET Power Transistor
Output Configuration	Sinking to Common (open drain)
Output Voltage, nominal	12/24Vdc
Output Voltage Range	0 to 28Vdc
Output Switch Rating	0.5A @ 20oC, derate linearly to 0.25A @ 80oC 3.0A peak (0.5 second surge)
Overvoltage & Transient Protection	Transorb
Overload Protection	Self Resetting Polymer Fuse
Flash ON/OFF times & Resolution	0 to 655.35 seconds in 10mS increments

COMMUNICATIONS (all models)

Serial Ports	1
Serial Port Interfaces	RS-232 and RS-485
Data Rate	2400 baud to 115K baud
Communications Protocol	Modbus RTU

ENVIRONMENTAL SPECIFICATIONS (all models)

Dimensions	1.38" W x 4.60" L x 2.85" (35mm x 117mm x 72mm)
Power (Input Voltage Range)	10 to 28Vdc
Power, Typical/Maximum	30mA / 35mA
Temperature, operating	-40°C to 75°C (-40°F to 167°F)
Temperature, storage	-40°C to 100°C (-40°F to 212°F)

Isolation, Field to Logic	2000 volts
Humidity	5 to 85% RH, (non-condensing)
Wiring Terminations	Removable Terminal Blocks
Wire Size	#14 to #26 stranded, #12 solid

Analog Input Modules

PicoBrick Analog Input modules accept signals from sensors that monitor levels, flows, temperatures, pressure, etc. Measurements are made with a high-accuracy 16-bit Analog-to-Digital (A/D) converter.

The PicoBrick Analog Input modules have a total of 8 analog inputs. There are two modules; one for voltage (5Vdc) and one for current (20mA).

Signal Types and Levels

The PicoBrick Voltage Analog Input module will accurately read signals up to 5.5Vdc (10% over-range). With standard calibration of the PicoBrick from the factory, inputs ranging from 0 to 5.5 volts will result in readings of 0 to 55000.

The PicoBrick Current Analog Input module will accurately read signals up to approximately 40mA (100% over-range). With factory calibration, a span of 0 to 40mA will result in corresponding readings of 0 to 40000 (20mA = 20,000). The module measures loop current by sensing the voltage drop across a precision 124Ω resistor. At 20mA, this resistor will reduce the available loop voltage (compliance) by approximately 2.5 volts.

Isolation and Input Protection

To help avoid ground loop effects, the PicoBrick Analog Input modules are optically isolated with a shared common. The inputs are also overload, surge, and reverse polarity protected by a combination of self-resetting polymer fuses and “Transorb” transient limiters. Input levels greater than 6Vdc (voltage input module) or 50mA (current input module), or negative signal levels (both modules) will cause the transient protection circuitry to start limiting the input signal. Greater overloads will cause the polymer fuses to increase in resistance protecting the internal input circuitry. During a full overload condition, the inputs will conduct some current, but that current is held at a safe level. When the fault is cleared, the input is restored back to normal operation automatically.

I/O Processor Functions

The PicoBrick Analog Input modules are supported by an intelligent I/O microprocessor. PicoBrick analog inputs are sometimes connected to the analog outputs of flow and wattage meters. In addition to indicating instantaneous flow or usage rates by the real-time analog readings, the PicoBrick will totalize the readings, accumulating samples of the analog inputs at periodic intervals. This provides a totalized flow or wattage usage over time. The sampling interval (or “gate time”) is user configurable.

Calibration

The calibration of the Analog Input modules is software controlled. Calibration tables for the analog inputs are stored in nonvolatile EEROM memory and calibration is performed by software techniques without opening the I/O module enclosure.

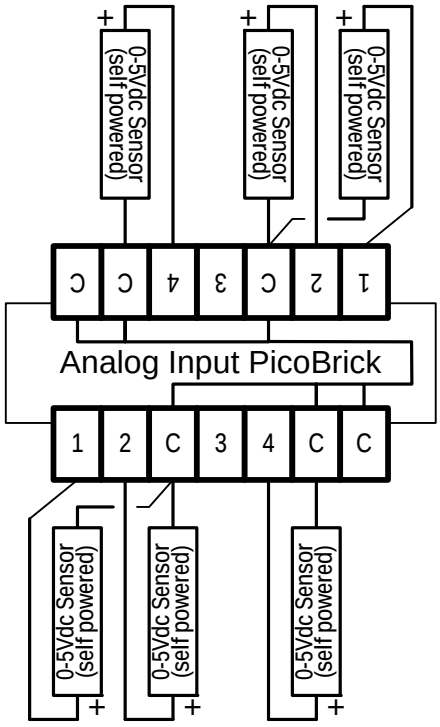
If you want to do your own calibration, contact ICL technical support for the recommended field calibration procedures and software tools.

Field Wiring

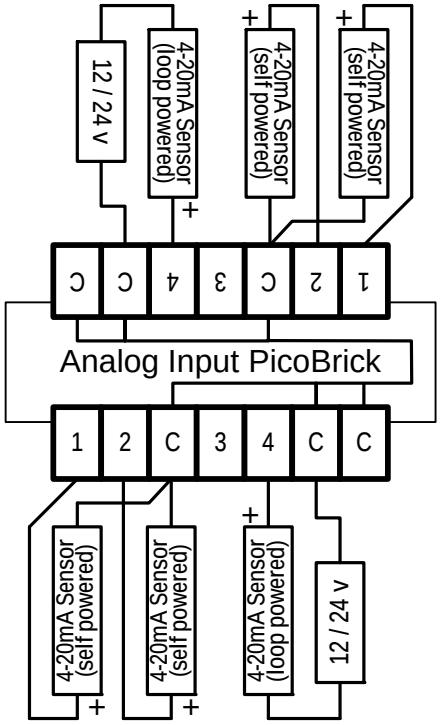
Analog Input signals come into the PicoBrick module on a pair of 7-position removable terminal blocks. There are 4 sensor input connections and 3 common connections on each terminal block. The common connections are electrically tied together within the PicoBrick, but isolated from the PicoBricks microprocessor, communications and power supply circuitry.

The Analog Inputs are passive and require an active signal source. 20mA current loop devices must either have their own internal loop power supplies, or an external supply must be used. The Analog Inputs are isolated, so that the power source for the loop devices can safely be the PicoBricks power supply without causing a ground loop. Voltage type sensors are typically self-powered. The user should ensure that self-powered devices are isolated from each other to avoid ground loops.

Typical Analog Input wiring configurations are shown on the next page.



Voltage (5V) Analog Input PicoBrick - Field Wiring Example



Current (20mA) Analog Input PicoBrick - Field Wiring Example

Modbus Register Map

PicoBrick Analog Input modules use the following Modbus register map:

STATUS (Input Bits - Modbus Type 10xxx)

none

COILS (Output Bits - Modbus Type 00xxx)

none

INPUT REGISTERS (Read Only 16-bit - Modbus Type 30xxx)

Start	*End*	*Description*
001	08	Analog Inputs 1 through 8
248	249	Reserved - ICL Test ONLY
250	-	Input Voltage (power) x 10 (143 = 14.3 volts)
251	254	Reserved - ICL Test ONLY
255	-	Firmware Revision
256	-	Device ID (AI8-16V = 2131, AI8-16I=2132)

HOLDING REGISTERS (Read/Write 16-bit - Modbus Type 40xxx)

Star	*End*	*Description*
001	016	Analog Input Totalizers - Inputs 1 through 8 (32-bit, 1st/Odd register is MSB)
132	-	Analog Totalizer Measurement Sampling Interval
133	140	Analog Input Mode - Inputs 1 through 8 (0 = “Raw”/uncalibrated, 1 = mA, 2 = 5V)
149	-	Input Power (voltage) calibration numerator (denominator = 65,535)
150	-	Analog Inputs 1 through 8 Voltage Mode Calibration numerator (denominator = 65,535) [Model#21-0031]
151	158	Analog Inputs 1 through 8 Current Mode Calibration numerator (denominator = 65,535) [Model#21-0032]
245	-	Store & Forward - Incoming Base Address
246	-	Store & Forward - Outgoing (remapped) Base Address
247	-	Store & Forward - Address Range (block size)
248	-	Communications Watchdog Timer (10mS increments)
249	-	Xmit Enable Delay (Xmit Enable to Xmit Data in 10mS increments)
253	-	Baud Rate Index (0 = 2400, 1 = 4800, 2 = 9600, 3 = 19200, 4 = 38400, 5 = 115200)
254	-	Status Register (0001h = restarted, 0002h = comm. timed out)
255	-	Reserved - Test Register - ICL Test ONLY
256	-	Reserved - Control Register - ICL Test ONLY

Specifications - Analog Input PicoBricks

Number of Analog Inputs	8
Input Type	Unipolar multiplexed inputs with shared Common
Input Levels, nominal	0 to 5Vdc (model# 21-0031) 0/4 to 20mA (model# 21-0032)
Input Overload Tolerance	Input voltage limit starts at 6Vdc (model# 21-0031) Input current limited to 50mA (model# 21-0032)
Overload/Transient Protection	Transorbs and self resetting polymer fuses
Conversion Rate	Approximately 2 samples per second at each point
Noise Rejection	-120dB @ 50/60Hz

COMMUNICATIONS (both models)

Serial Ports	1
Serial Port Interfaces	RS-232 and RS-485
Data Rate	2400 baud to 115K baud
Communications Protocol	Modbus RTU

ENVIRONMENTAL SPECIFICATIONS (all models)

Dimensions	1.38" W x 4.60" L x 2.85" D (35mm x 117mm x 72mm)
Power (Input Voltage Range)	10 to 28Vdc
Power, Typical/Maximum	30mA / 35mA
Temperature, operating	-40°C to 75°C (-40°F to 167°F)
Temperature, storage	-40°C to 100°C (-40°F to 212°F)
Isolation, Field to Logic	2000 volts
Humidity	5 to 85% RH, (non-condensing)
Wiring Terminations	Removable Terminal Blocks
Wire Size	#14 to #26 stranded, #12 solid

Analog Output Module

PicoBrick Analog Output modules operate control devices such as variable speed drives and positioners as well as display and operator interface devices such as panel meters and chart recorders.

Signal Types and Levels

The PicoBrick Analog Output module has 6 4-to-20mA analog outputs. Each output is individually isolated and powered by the loop that it controls. With factory calibration, the Host system controls each output by setting the output channels register to a value between 4000 (4mA) and 20,000 (20mA). The analog outputs reduce the available loop voltage (compliance) by about

Isolation and Output Protection

To help avoid ground loop effects, the PicoBrick Analog Output modules are optically isolated, between the field connections and the internal logic, and from analog output channel to analog output channel. The outputs are also transient and surge protected by a combination of self-resetting polymer fuses and "Transorb" transient limiters. Loop voltages or transients that might exceed the modules ratings will cause the transient protection circuitry to start limiting the output signal. Greater overloads will cause the polymer fuses to increase in resistance protecting the internal output circuitry. During a full overload condition, the outputs will conduct some current, but that current is held at a safe level. When the fault is cleared, the output is restored back to normal operation automatically.

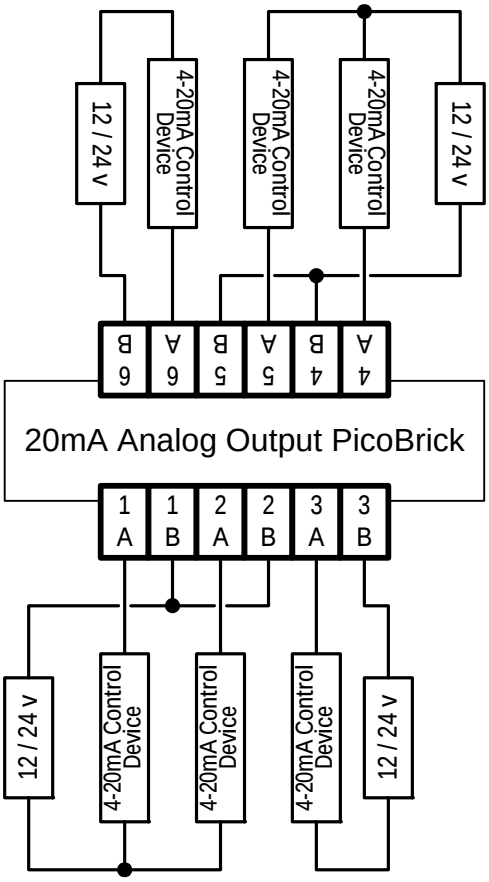
Calibration

The calibration of the Analog Output modules is software controlled. Calibration tables for the analog outputs are stored in nonvolatile EEROM memory and calibration is performed by software techniques without opening the I/O module enclosure.

If you want to do your own calibration, contact ICL technical support for the recommended field calibration procedures and software.

Field Wiring

The Analog output connections are on a pair of 6-position removable terminal blocks. There are 3 pairs of output connections, one pair per output channel, on each terminal block. The outputs are not polarity sensitive. Being isolated and polarity insensitive means that the outputs may be inserted into any point in the control loop. Typical wiring to the Analog Outputs is pictured in the diagram on the next page.



Each analog output is isolated from the others, so loop supplies can be shared or isolated without causing ground loops. The analog outputs are NOT sensitive to polarity.

Analog Output PicoBrick - Field Wiring Example

Modbus Register Map

PicoBrick Analog Output modules use the following Modbus register map:

STATUS (Input Bits - Modbus Type 10xxx)

none

COILS (Output Bits - Modbus Type 00xxx)

none

INPUT REGISTERS (Read Only 16-bit - Modbus Type 30xxx)

Star	*End*	*Description*
248	249	Reserved - ICL Test ONLY
250	-	Input Voltage (power) x 10 (143 = 14.3 volts)
251	254	Reserved - ICL Test ONLY
255	-	Firmware Revision 256 -Device ID (AO8-12I=2142)

HOLDING REGISTERS (Read/Write 16-bit - Modbus Type 40xxx)

Start	*End*	*Description*
001	006	Analog Outputs - 1 through 6 (4000 to 20000 = 4mA to 20mA)
149	-	Input Power (voltage) calibration numerator (denominator = 65,535)
161	166	Analog Outputs 1 through 6 - calibration numerators (denominator = 65,535)
186	191	Analog Outputs 1 through 6 - calibration offsets
245	-	Store & Forward - Incoming Base Address
246	-	Store & Forward - Outgoing (remapped) Base Address
247	-	Store & Forward - Address Range (block size)
248	-	Communications Watchdog Timer (10mS increments)
249	-	Xmit Enable Delay (Xmit Enable to Xmit Data in 10mS increments)
253	-	Baud Rate Index (0 = 2400, 1 = 4800, 2 = 9600, 3 = 19200, 4 = 38400, 5 = 115200)
254	-	Status Register (0001h = restarted, 0002h = comm. timed out)
255	-	Reserved - Test Register - ICL Test ONLY
256	-	Reserved - Control Register - ICL Test ONLY

Specifications - Analog Output PicoBrick

Number of Analog Outputs	6
Output Type Loop Powered Current Loop	
Output Levels, nominal	4 to 20mA
Resolution	12-bits (1 part in 4096)
Overload/Transient Protection	Transorbs and self resetting polymer fuses
Conversion Rate	Approx. 100 conversions per second, each output

COMMUNICATIONS (both models)

Serial Ports	1
Serial Port Interfaces	RS-232 and RS-485
Data Rate	2400 baud to 115K baud
Communications Protocol	Modbus RTU

ENVIRONMENTAL SPECIFICATIONS (all models)

Dimensions	1.38" W x 4.60" L x 2.85" D (35mm x 117mm x 72mm)
Power (Input Voltage Range)	10 to 28Vdc
Power, Typical/Maximum	30mA / 35mA
Temperature, operating	-40°C to 75°C (-40°F to 167°F)
Temperature, storage	-40°C to 100°C (-40°F to 212°F)
Isolation, Field to Logic	2000 volts
Humidity	5 to 85% RH, (non-condensing)
Wiring Terminations	Removable Terminal Blocks
Wire Size	#14 to #26 stranded, #12 solid

"Combo" I/O Modules

PicoBrick "Combo" I/O modules provide a mix of discrete inputs, discrete outputs and analog inputs. They are an economical alternative to using separate modules when smaller quantities of I/O are needed. Because of their mix of I/O, "Combo" PicoBricks are frequently used as low-cost Modbus Remote Terminal Units (RTUs).

Combo PicoBricks have 3 16-bit Analog Inputs, 3 Discrete Inputs (12/24V or 120V models), and 2 discrete (FET) outputs. The functionality of each section is identical to their equivalent PicoBrick module. In addition, the Discrete Input section has programmable filtering on 2 of the 3 inputs. When the filters are switched OFF, these two discrete inputs support high-speed counting rates of up to 5 KHz (5,000 pulses per second).

Combo Module Discrete Input Section

PicoBrick Combo module Discrete Inputs are used to monitor the state of switches, relays contacts, motor starter auxiliary contacts and any other on/off type sensor signal. The inputs are optically isolated to avoid ground loop effects and damage from transients and power surges. There are a total of 3 discrete inputs with a shared common.

Signal Types and Levels

PicoBrick Combo module Discrete Inputs have a unique input design that accepts both AC and DC signals. The inputs are not sensitive to signal polarity, supporting DC sensors with either "sinking" or "sourcing" output configurations as well as switch contacts with AC or DC signals.

Currently, there are two models of PicoBrick Combo Modules; one designed for low-voltage (12/24V) discrete inputs, the other for 120V discrete inputs. In the low voltage model, an input level of 9 volts (AC/DC) or greater is considered to be an "ON". Input levels of 6 volts (AC/DC) or less are considered OFF. The inputs can accept signal levels of up to 50 volts (AC/DC) and tolerate overloads of nearly twice that. The 120V model responds to inputs of 75V or greater as an "ON", 50V or less as an "OFF" and will tolerate a 100% overload.

LED Input Status Indicators

Each discrete input has an LED indicator to show the current ON or OFF state of the input.

I/O Processor Functions

The discrete inputs are supported by a microprocessor that performs input noise filtering, pulse totalization and pulse rate computation, helping to off-load the Host Controller and improve system performance.

Input Filtering

The discrete inputs have filtering that rejects spurious noise and limits the maximum counting rate to 40Hz with DC pulses, up to 10Hz with AC signals.

Pulse Totalization

PicoBrick Combo module Discrete Inputs count ON transitions for every input point, providing reliable pulse totalization that is not sensitive to communications rates and I/O scan time. This feature can be used for very accurate flow and wattage totalization. The 1st and 2nd inputs have software controlled filtering. When the filters are turned OFF, the inputs support high-speed counting up to 5KHz. When the filters are enabled, their response is identical to “normal” discrete inputs.

The pulse totalizers are 32-bit counters, meaning that the totalizers count up to 4,294,836,225 ON transitions before they “roll over” to zero again. The counters can be reset or preset to any value at any time.

Runtime Totalization

PicoBrick Combo module Discrete Inputs monitor the runtime (ON time) for every input, providing reliable “down-to-the-second” information on how long an input has been “ON”. This information is useful for equipment maintenance and wear leveling. An example is the use of runtime to determine which pump should be used based on which pump has seen the least usage.

The runtime totalizers are 32-bit registers, meaning that the totalizers count seconds, up to 4,294,836,225 before they “roll over” to zero again. The runtime totalizers can be reset to zero or preset to a value at any time by simply writing to the appropriate register.

Pulse Rate Calculation

PicoBrick Combo module Discrete Inputs calculate the input pulse rate for every input. With the appropriate sensors, this can be used to show “real-time” flow, usage rates, and speeds. A software settable “gate” time determines the measurement interval over which the input pulses are counted. Longer gate time intervals provide greater measurement resolution, but the measured value is updated less frequently. The gate time is the measurement update interval. Once the gate time has expired, each totalized count is stored in a Modbus register for that discrete input, and a new set of rate totalization measurements are started.

Combo Module Discrete Output Section

PicoBrick Combo module Discrete Outputs are used to control relays, motor starters, lights, annunciators and any other on/off type control device. The Combo modules provide 2 solid state FET (protected transistor) outputs. FET transistors are extremely efficient and consume very little power, ideal for solar and battery backed systems. If a “dry” relay contact is required, a FET output can drive an interposing relay.

The FET outputs are isolated as well as overload, surge, and reverse polarity protected by self-resetting polymer fuses and “Transorb” transient limiters. Because of the built-in transient protection, a suppression diode is typically not required across relay coils or other inductive loads.

The FET outputs are designed to operate in 12 and 24 volt control systems, with control voltages of up to 28 volts DC. An external power source is NOT required to power the PicoBrick FET output circuitry, but IS required by the load devices. FET outputs ARE sensitive to signal polarity, driving DC control devices with an open drain output that switches to a common “ground”. When turned ON, the outputs have a very low (< 2Ω) resistance to the common. When turned OFF, the outputs exhibit very high resistance and low leakage that will not provide a false ON to sensitive controller inputs like other solid state outputs have in the past. If an output drives a low resistance or shorted load, it will be protected automatically by switching to a low current state high resistance state. The output will continue to sink some current in this condition until the overload is removed. Once the fault condition is cleared, the output will automatically switch back to its normal low resistance, driving the full current required by the load.

LED Output Status Indicators

Each discrete output has an LED indicator to show the current ON or OFF state of the output.

I/O Processor Functions - Discrete Outputs

PicoBricks are sometimes used to flash alarm indicators remotely, but without help from the on-board microprocessor, variations in communications and I/O scan time can make the flashing look erratic. Both of the PicoBrick Combo Module discrete outputs have a precise flashing capability that is independent of communications I/O speed or scan time. Two control bits are used per output; one to turn the output ON or OFF, the second to command the output to flash whenever it is turned ON by the first bit. A separate Modbus register sets the flashing rate.

Combo Module Analog Input Section

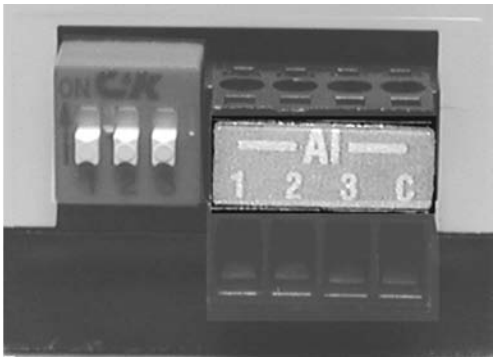
PicoBrick Combo module Analog Inputs accept signals from sensors that monitor levels, flows, temperatures, pressure, etc. Measurements are made with a high-accuracy 16-bit Analog-to-Digital (A/D) converter. The Combo modules have a total of 3 analog inputs.

Signal Types and Levels

PicoBrick Combo module Analog Inputs may be configured to accept 5V or 20mA process control signals. For each analog channel, the user configures the I/O module for the correct input mode (voltage or current). The configuration information is nonvolatile and need only be set once unless the system is changed. The Module uses the configuration information to determine which calibration tables to use for processing analog input conversion data for each channel. The user must also set switches on the side of the Module that enable precision current sense resistors that are required for 20mA operation but are not used for 5Vdc operation.

When configured for 5Vdc operation, the PicoBrick Combo module Analog Inputs will accurately read signals up to 5.5Vdc (10% over-range). With standard calibration from the factory, input signals ranging from 0 to 5.5 volts will result in readings of 0 to 55000. When configured for 20mA operation, the Module will accurately read signals up to approximately 40mA (100% over-range). With factory calibration, a span of 0 to 40mA will result in corresponding readings of 0 to 40000 (20mA = 20,000). When an analog input is configured for 20mA operation, a precision 124Ω resistor is used to measure current flow. At 20mA, this resistor will reduce the available loop voltage by approximately 2.5 volts.

Whenever an analog input is configured for voltage or current mode, a corresponding DIP switch next to the Analog Input terminal block must be set. The switches are numbered 1 through 3 corresponding to input channel numbering. For each channel, set the switch UP for current operation (20mA), DOWN for voltage operation (5Vdc).



Combo PicoBricks - Analog Input Configuration Switches and Terminal Block

Isolation and Input Protection

To help avoid ground loop effects, the PicoBrick Combo module Analog Inputs are optically isolated with a shared common. The inputs are also overload, surge, and reverse polarity protected by a combination of self-resetting polymer fuses and "Transorb" transient limiters. Input levels greater than 6Vdc or 50mA, or negative signal levels, will cause the transient protection circuitry to start limiting the input signal. Greater overloads will cause the polymer fuses to increase in resistance protecting the internal input circuitry. During a full overload condition, the inputs will conduct some current, but that current is held at a safe level. When the fault is cleared, the input is restored back to normal operation.

I/O Processor Functions

PicoBrick Combo module Analog Inputs are sometimes connected to the analog outputs of flow and wattage meters. In addition to indicating instantaneous flow or usage rates by the real-time analog reading, the Combo PicoBrick will totalize the readings, accumulating samples of the analog inputs at periodic intervals. This provides a totalized flow or wattage usage over time. The sampling interval (or "gate time") is user configurable.

Analog Input Calibration

The Analog Input calibration is software controlled. Calibration tables for the analog inputs are stored in nonvolatile EEROM memory and calibration is performed by software techniques without opening the I/O module enclosure.

If you want to do your own calibration, contact ICL technical support for the recommended field calibration procedures and software.

Combo Module Field Wiring

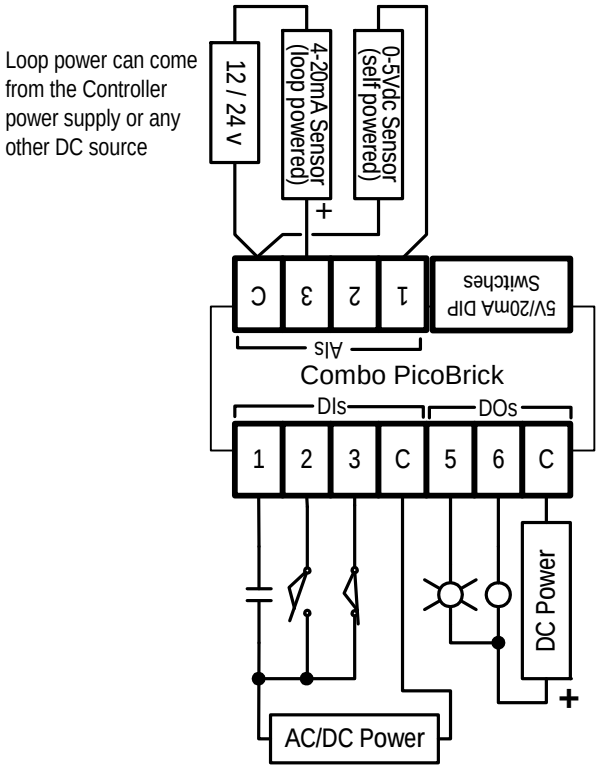
Combo Module discrete I/O field wiring terminates at a 7-position removable terminal block. The three inputs have one isolated common, and the two outputs have their own isolated common. The Analog Inputs use a 4 position terminal block; 3 sensor input terminals and an isolated common.

The Discrete Inputs require an active voltage to be switched between their common and the input signal connections. The inputs are isolated, so the power source for the inputs can be the PicoBricks power supply without causing a ground loop. The discrete inputs are not sensitive to polarity. The input current at 12Vdc is approximately 1mA, sufficient for contact "wetting", but low enough for use in solar and battery-backed applications.

The discrete outputs are "open-drain" FET transistors that require a positive supply voltage on one side of the loads, while the outputs switch the other side of the loads to the power return. The power return must be connected to the negative side of the power source.

The analog inputs require an active signal source. 20mA current loop devices must either have their own internal loop power supplies, or an external supply

must be used. The analog inputs are isolated, so that the power source for the loop devices can be the PicoBricks power supply without causing a ground loop. Voltage type sensors are typically self-powered. The user should ensure that self-powered devices are isolated to avoid ground loops through individual sensors.



Modbus Register Map

STATUS (Input Bits - Modbus Type 10xxx)

Start	*End*	*Description*
001	003	Discrete Inputs 1 through 3 (w/forcing)
033	035	Raw Discrete inputs 1 through 10 (no forcing)

COILS (Output Bits - Modbus Type 00xxx)

Start	*End*	*Description*
001	002	Discrete Outputs 1 and 2
033	034	Flash Enables 1 and 2

INPUT REGISTERS (Read Only 16-bit - Modbus Type 30xxx)

Start	*End*	*Description*
001	003	Analog Inputs 1 through 3
004	006	Pulse Rate - Discrete Inputs 1 through 3
248	249	Reserved - ICL Test ONLY
250	-	Input Voltage (power) x 10 (143 = 14.3 volts)
251	254	Reserved - ICL Test ONLY
255	-	Firmware Revision
256	-	Device ID (Combo-24 = 2151, Combo-120 = 2152)

HOLDING REGISTERS (Read/Write 16-bit - Modbus Type 40xxx)

Start	*End*	*Description*
001	006	Pulse Totalizers - Inputs 1 through 3 (32-bit, 1st/Odd register is MSB)
007	012	Runtime Totalizers - Inputs 1 through 3 (32-bit, 1st/Odd register is MSB)
013	018	Analog Input Totalizers - Inputs 1 through 6 (32-bit, 1st/Odd register is MSB)
129	-	Rate Measurement “Gate” (sampling) Time
130	-	Discrete Inputs 1 and 2 - Filter Select (0001h = DI 1 - fast, 0002h = DI2 - fast)
131	-	Discrete Outputs Flash Rate ON/OFF time (half duty cycle) in 10mS. increments
132	-	Analog Totalizer Measurement Sampling Interval
133	135	Analog Input Mode - Inputs 1 through 3 (0 = “Raw”/uncalibrated, 1 = mA, 2 = 5V)
149	-	Input Power (voltage) calibration numerator (denominator = 65,535)
150	-	Analog Inputs 1 through 3 Voltage Mode calibration numerator (denominator = 65,535)
151	153	Analog Inputs 1 through 3 Current Mode calibration numerator (denominator = 65,535)
245	-	Store & Forward - Incoming Base Address
246	-	Store & Forward - Outgoing (remapped) Base Address
247	-	Store & Forward - Address Range (block size)
248	-	Communications Watchdog Timer (10mS increments)
249	-	Xmit Enable Delay (Xmit Enable to Xmit Data in 10mS increments)
253	-	Baud Rate Index (0 = 2400, 1 = 4800, 2 = 9600, 3 = 19200, 4 = 38400, 5 = 115200)
254	-	Status Register (0001h = restarted, 0002h = comm. timed out)
255	-	Reserved - Test Register - ICL Test ONLY
256	-	Reserved - Control Register - ICL Test ONLY

Specifications - Combo I/O PicoBricks

12/24V COMBO PICOBRICK DISCRETE INPUTS (Model# 21-0051)

Number of Discrete Inputs	3
Input Type	Bipolar Optocoupler
Input Voltage, nominal	12/24 Vdc/ac
Input Voltage Range	0 to 60 Vdc/ac
Input Overvoltage Tolerance	85Vdc/Vac
Input Resistance, typical	10,000 ohms
Input Noise Filtering, AC/DC	20Hz / 100Hz
Counting Frequency, AC/DC	10Hz / 50Hz

120V COMBO PICOBRICK DISCRETE INPUTS (Model# 21-0052)

Number of Discrete Inputs	3
Input Type	Bipolar Optocoupler
Input Voltage, nominal	120 Vdc/ac
Input Voltage Range	0 to 125 Vdc/ac
Input Overvoltage Tolerance	190Vdc/Vac
Input Resistance, typical	100,000 ohms
Input Noise Filtering, AC/DC	20Hz / 100Hz
Counting Frequency, AC/DC	10Hz / 50Hz

COMBO PICOBRICK FET DISCRETE OUTPUTS (both models)

Number of Discrete Outputs	2
Output Type FET	Power Transistor
Output Configuration	Sinking to Common (open drain)
Output Voltage, nominal	12/24Vdc
Output Voltage Range	0 to 28Vdc
Output Switch Rating	0.5A @ 20oC, derate linearly to 0.25A @ 80oC 3.0A peak (0.5 second surge)
Overvoltage & Transient Protection	Transorb and Self Resetting Polymer Fuse
Flash ON/OFF times & Resolution	0 to 655.35 seconds in 10mS increments

COMBO PICOBRICK ANALOG INPUTS (both models)

Number of Analog Inputs	3
Input Type	Unipolar multiplexed inputs with shared Common
Input Levels, nominal	0 to 5Vdc, 0/4 to 20mA
Input Overload Tolerance	Input voltage limiting starts at 6Vdc Input current limited to 50mA
Overload/Transient Protection	Transorbs and self resetting polymer fuses
Conversion Rate	Approximately 5 samples per second at each point
Noise Rejection	-120dB @ 50/60Hz

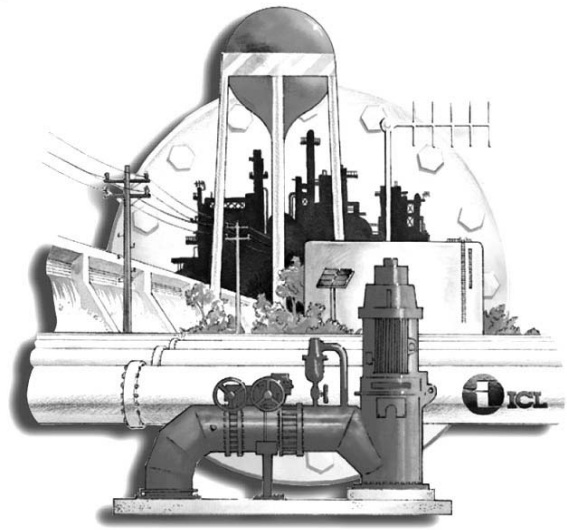
COMMUNICATIONS (both models)

Serial Ports	1
Serial Port Interfaces	RS-232 and RS-485

Data Rate	2400 baud to 115K baud
Communications Protocol	Modbus RTU

ENVIRONMENTAL SPECIFICATIONS (all models)

Dimensions	1.38" W x 4.60" L x 2.85" D (35mm x 117mm x 72mm)
Power (Input Voltage Range)	10 to 28Vdc
Power, Typical/Maximum	30mA / 35mA
Temperature, operating	-40°C to 75°C (-40°F to 167°F)
Temperature, storage	-40°C to 100°C (-40°F to 212°F)
Isolation, Field to Logic	2000 volts
Humidity	5 to 85% RH, (non-condensing)
Wiring Terminations	Removable Terminal Blocks
Wire Size	#14 to #26 stranded, #12 solid



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