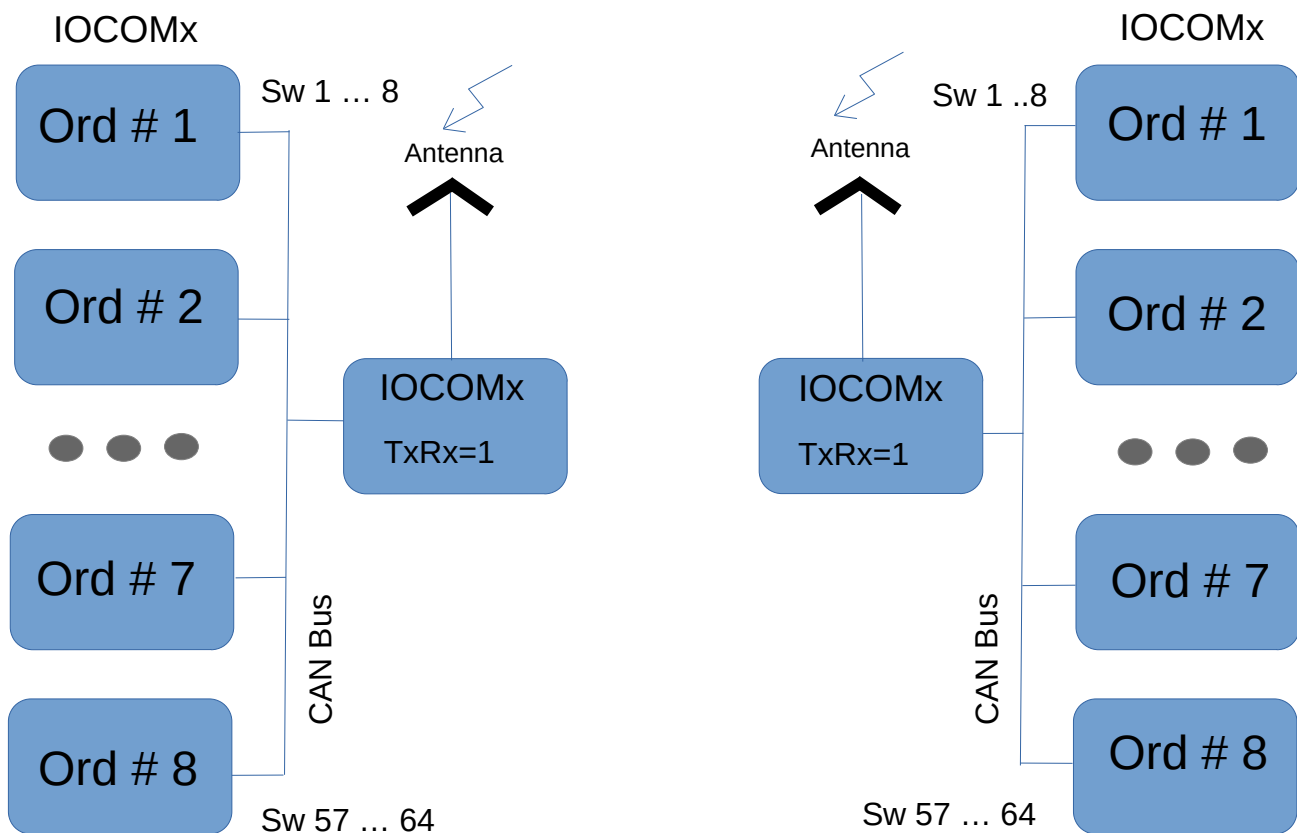# IOCOMx

Developer's manual and installation manual

The IOCOMx device transmits and receives switch states between sender and receiver, and operates a relay based upon the state of the remote switch. An individual system is capable of both transmission and reception simultaneously.

Additional information may be found at: https://github.com/akostarinc/IOCOM8-Support

Communication Schematic

The IOCOMx system may consist of several, separate devices (modules). Each module can take care of eight individual channels, and up to eight modules can be grouped into a system. This results in total capability of 64 channels. If desired, less modules may be grouped.

The modules receive an ordinal number from configuration, and the ordinal number determines the range of switches this module will represent in the transmit / receive process.

Table of Contents

Document Versioning:

Release Name	Version	Initials
Initial Release of predecessor	1.0 at Thu 29.Apr.2021	PG
Initial Release of IOCOMx	2.0 at Thu 15 Jul 2021	CB PG
Document Additions	Mon 18 Oct 2021	PG

Firmware Versioning:

Release Name	Firmware	Initials
First Board	Wed 30.Jun.2021	CB
Initial Release	Thu 15 Jul 2021	PG
Ready for Product Release	Tue 19 Oct 2021	CB PG

Introduction

Up to eight IOCOMx modules can be grouped into one system. The following table contains the chart of modules and their corresponding port ranges.

Module Count	Ordinal	Port Total	Port Ranges
1	1	8	1-8
2	2	16	1-8; 9-16;
3	3	24	1-8; 9-16; 17-24;
4	4	32	1-8; 9-16; 17-24; 25-32;
5	5	40	1-8; 9-16; 17-24; 25-32; 33-40;
6	6	48	1-8; 9-16; 17-24; 25-32; 33-40; 41-48;
7	7	56	1-8; 9-16; 17-24; 25-32; 33-40; 41-48; 49-56;
8	8	64	1-8; 9-16; 17-24; 25-32; 33-40; 41-48; 49-56; 57-64;

The **IOCOMx** receives and decodes signals, and pulls / releases relays based upon the content of the received transmission. The transmission is omnipresent, the reception is selective. This permits that any

number of receivers can listen to the transmitting device. It also permits that additional tools to be deployed, which may monitor communications for expansions; ex: like statistics / accounting.

The IOCOMx communication is encrypted, without the proper key and decryption algorithm it is not feasible to decode communications. The communication is also marked by a hash (signature), which makes it secure against tempering. The IOCOMx uses state of the art - industry accepted - algorithms, that are known to be secure and unbreakable at the time of this writing. (Oct, 2021)

There are no system coexistence limits, multiple systems may be deployed in the same airspace. Up to eight IOCOMx modules can be connected to a single bus in a single system.

Please note that the terms relay on / relay closed is used for 'relay energized' and relay off / relay opened is used for relay 'de-energized'; The words button / switch / input are used interchangeability and denote user input.

IOCOMx Pairing

The IOCOMx system comes paired from the manufacturer. Should (re) pairing be needed, Double click (press 2 times) the configuration button on the face of the **Transmitter** unit, and triple click (press 3 times) the configuration button on the **Receiver** unit. The devices will communicate and pair. (Note: the timing of the clicks is similar to the mouse 'double' click, but instead of two clicks, click it two or three times)

During the pairing process, the unit's LED will flash on and off. When the Receiver is successfully paired the pairing LED will flash rapidly five times. If no pairing request is completed, the pairing mode will time-out in 15 seconds.

Note, that this configures the communication one way, from transmitter to receiver. If you would like to configure the devices for bi-directional communication, repeat the process with the order of double click / triple click reflecting the reverse communication direction.

If the receiving unit has no pairing space available (already paired four units) the LED One and LED Two will strobe for 5 seconds.

The pairing process will time out in 15 seconds if no valid pairing information was received. One may retry the pairing process any number of times.

The receiver cannot be paired if the number of devices has reached the pairing limit (the limit is currently: four) The transmitter has no pairing limit.

If you encounter difficulty during the pairing process with the Receiver, long press the configuration button for 10 seconds, and the device will clear all pairing data. This allows a fresh start for all pairing related operations.

*Note that after the long press all the other devices that where paired to this receiver need to be re-paired.

Technical Details:

Encryption and Checksum:

The IOCOMx system communicates with an encrypted data stream. Listening to the data with external devices yields the appearance of random data. As every packet is different, the operational intent is not decipherable without the correct encryption key. The data packet is also protected with a checksum and will reject packets with an invalid checksum.

Configuration Button codes:

The configuration button has multiple functions. A single click wakes up the system, if it is in sleep mode, otherwise it is a no-op (does nothing). A double click starts the pairing process on the transmitter. The pairing process times out in 15 seconds. A triple click starts the pairing process on the receiver side.

This has similar properties as the transmitter counterpart, times out in 15 seconds. A quad click (4 clicks) starts the configuration web page. A second set of quad clicks stops the web configuration process. The web configuration mode stops if there is no web activity for one minute. A Penta click (five clicks) reboots the device.

Clicks	No. of clicks	Function	Description
Single Click	1	No-Op	Does nothing
Double Click	2	Start pairing	Transmitting side
Triple click	3	Start listening for pairing	Receiving side
Quad Click	4	Start configuration	Start Config Web server
Penta Click	5	Reboot	Restart the IOCOMx device
Hexa Click	6	Start relay test. Relays click on in succession then off.	Manufacturer / installer test procedure.
Septa Click	7	Start input to output mirror	The state of the relays are mirrored to the output. This function will reset on restart.
Octa Clicks	8	Switch all relays on.	For testing. This function will reset on restart.

Long Press Reset

Press and hold configuration button for ten+ seconds to reset the device to manufacturer's defaults. The parameters are reset to their original values, and the Network Name is reset to IOCOM-XXXX where XXXX is part of the MAC address of the device. The network password is reset to 12345678

LED indicator codes:

The indicator LEDs have multiple functions. At its fundamental function it will flash when an ON transmission occurs. If the device is in pairing mode the LED will flash on and off during pairing process. If the device is in Configuration / Web mode, the LED will flash slowly on and off during Configuration / Web mode. If there are any error conditions, the LED will flash rapidly for a short period of time. (led strobe mode)

Pairing Diversity:

The IOCOMx can be paired with four other devices. With the IOCOMx transceiver device, the pairing direction is established by the button press order: the double click prompts the unit internally as the Transmitter pairing initiate, the triple click is Receiver paring initiate. As one IOCOMx device can accommodate four paired devices, it is possible to configure many combinations of control networks. For instance, up to four transmitters can be configured to control one receiver. In another instance, one transmitter may control four (or more) receivers simultaneously. The combination of control is not limited in any way beyond the receiver's maximum pair count.

Pairing Recovery:

A long press of 10 seconds will reset the device to manufacturer's defaults. Network Name is reset to IOCOM-XXXX and the network password is reset to 12345678. All pairings are lost, and need to be re paired.

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Web based Configuration

The iocomx device can be configured from a web interface. Pressing the configuration button Four times will start the configuration web server. One can connect to this web page via a WiFi access point, under the IOCOM-NNNN name. (NNNN being a unique id for this unit)

Below is a partial screen shot of the web interface's first page.

IOCOM8 Transceiver
CAN BUS Expandable Edition
An Akostar Product

General Configuration:

This name is provided to give the device an identifier. It can be any name, a stock number or the name of the device it controls. This name does not participate in any network parameter or communication process, it is simply to identify this unit. Please note that the terms IOCOM8 and IOCOMx are used interchangably, as IOCOMx is identical to IOCOM8, but it is meant to be in the multi device context.

Device Name: IOCOM_7A15

Save Configuration

Transmit Power Configuration:

The IOCOM8 transmitter can save power and increase RF coexistance by reducing transmission power. The power can be set in seven steps, from Low to High, Left to Right. This setting can be also used to limit the maximum range the transmitter is effective.

Low   Medium   High

○ 2dBm   ○ 5dBm   ○ 7dBm   ○ 11dBm   ○ 14dBm   ○ 16dBm   ● 20dBm

Save Configuration

Repeat Interval for the ON signal:

While the button is pressed, and held, the transmitter repeats a 'keep alive' signal. This is how the receiver knows that the button is still pressed. This way, the receiver can detect RF dropout, and take the appropriate action. (open the relays) The unit of below timing is in milli seconds. It is recommended to leave this setting at it's default, and only change it if circumstances demand it.

○ 200 ms   ● 300 ms   ○ 500 ms   ○ 700 ms

Save Configuration

Repeat Count for the OFF Signal:

When any control button is released, the transmitter transmits the 'OFF' signal several times. This configuration item determines the number of times the signal is repeated. It is OK to leave this setting unchanged.

○ 1x   ○ 2x   ○ 3x   ● 4x   ○ 5x   ○ 6x   ○ 8x

Save Configuration

On the screenshot to the left, pictured are the default settings of the device. They are chosen carefully to match most situations the device may be required to do.

Device Name: this setting is to identify the device. A good name may be the device the IOCOMx is connected to. Like: Crane_1. This setting has no effect on operation.

No change needed here, unless limited range is desired.

No change is needed here, unless slower or faster response is required.

No change is needed here, unless the off signal needs more repetition for safe off state communication.

Web Page Setup, Enable Configuration

The IOCOMx system starts up in transmit / receive mode. To enter configuration mode, quad click the configuration button. (click 4 times) the configuration button. (the timing of the click is similar to the mouse 'double' click, but instead of two clicks, click it four times)

The LED will flash on and off slowly to signify that the device is in configuration mode. One may connect to the device's web page, and configure it. If no web communication activity occurs in one minute, the device will terminate the configuration mode, and - after reboot - resumes in communication mode.

General Configuration:

The device can be named, and this name is provided to give the device an arbitrary identifier. It can be any name, a stock number or the name of the device it controls. This name does not participate in any network parameter or communication process, it is simply to identify this device. A good name choice is the name of the equipment it controls. Changing this name is optional.

Transmit Power Configuration:

The IOCOMx battery powered transmitter can save battery life by reducing transmission power. The power can be set in seven steps, from Low to High, Left to Right.

<div align="center">

Low Power   Medium Power   High Power

2dBm   5dBm   7dBm   11dBm   14dBm   16dBm   20dBm

</div>

Repeat Interval for the ON signal:

While the button is pressed, and held, the transmitter repeats a 'keep alive' signal. This is how the receiver detects that the button is still pressed. The timing of the interval is in milli seconds. Manufacturer's defaults are chosen to work in most situations. One may change this to accommodate a variety of conditions. This setting auto adjusts the 'Auto Release' timing of the receiver to match the transmitted delay.

<div align="center">

200 ms   300 ms   500 ms   700 ms

</div>

Repeat Count for the OFF Signal:

When a control button is released, the transmitter transmits the 'OFF' signal several times. This configuration item determines the number of times the signal is repeated. Manufacturer's defaults are chosen to work in most situations.

<div align="center">1x   2x   3x   5x   6x   8x</div>

This setting can be set between 1-8, the factory default for this option is set to 3. Set it to larger values if lost packets are encountered or anticipated.

Please remember to press the 'Save Configuration' button to commit your changes. All Save buttons save items for the whole page.

Network Name Configuration:

The network configuration fields determine the Station Name and Password of this IOCOMx. The device will appear on your WiFi network by this name. For safety and security, the IOCOMx may be configured with a password. The password needs to be at least 8 characters or longer. Please avoid using space, punctuation marks and non ASCII characters. You may use the _ (underscore) - (minus sign) and the + (plus sign).

If you encounter difficulty during the password change process, a long press on the configuration button (press and hold for appx. 10 seconds) will reset the receiver and will clear all passwords. This reset will also clear the pairing data, the existing pairings will need to be re-paired.

Can / Port allocation Page

The IOCOMx will Send / Receive data via its RF transceiver. This page allows one to configure which board in the stack is dedicated to transmit / receive. Naturally, the board to be dedicated needs to be equipped with the proper cable / antenna, other than that any of the units can be elected to be the transmit / receive board. This may come handy in an outage, simply reconfigure a different board to be the TxRx board.

IOCOM8 Transceiver
CAN BUS Expandable Edition
CAN bus config page

CAN Bus Configuration:

The IOCOMx will Send / Receive data via its RF transceiver. Only one RF transceiver is permitted per group. If this unit is a member of a group, and there is already a transmitter active, the CAN status LEDs will show the error sequence, (rapid flash) and the unit is set into error state;

If there are no RF transceivers in the group, the CAN status LEDs will show the error sequence, and no transmissions will (or can) occur.

Use RF from this module: ☑ (make this the TxRx)

Dedicate this board as TxRx. Please note that only ona board per stack may be dedicated as such.

IO Port Range / Ordinal:

The setting below determines the port allocation for this unit. Ordinal zero means this is a standalone unit; all the other ordinals are part of a group.

If this unit is a member of a group (connected by a CAN bus) and there are other units with the same port allocation, the CAN status LED will show the error sequence, and the unit will not accept / transmit input.

If this is configured as a single unit, (ordinal 0 and no CAN peers), it will be promoted to primary, (TxRx) and the RF will be activated automatically.

If new units come on line after the power up sequence, the CAN bus is re-scanned, and the rules set forth here will apply dynamically.

The ordinals may be discontinuous, provided that there is matching discontinuity on the receiving end.

Ordinal: 0 (ports: 1-8) Standalone Unit ○

Ordinal: 1 (ports: 1-8) ○	Ordinal: 2 (ports: 9-16) ○
Ordinal: 3 (ports: 17-24) ○	Ordinal: 4 (ports: 25-32) ○
Ordinal: 5 (ports: 33-40) ○	Ordinal: 6 (ports: 41-48) ○
Ordinal: 7 (ports: 49-56) ○	Ordinal: 8 (ports: 57-64) ◉

The manufacturer's reset will default to board zero. (standalone unit)

Can Bus Parameters

The CAN bus features can be controlled from this section.

CAN Bus All STOP:

If the CAN bus detects an unexpected CAN disconnection, the whole IOCOMx system may be commanded to go into shutdown mode by issuing an ALL STOP command. In shutdown mode, the Relays are disengaged, (opened) and the system will not accept further commands from the remote unit.

In some cases, this may not be the desired behavior. So if and when the checkbox below is checked, the system will not go into shutdown mode, and preserves it's current state. Depending on the point of CAN disconnection, the disconnected CAN bus will have its expected effect. Note (*): If a unit is not attached on power up, it will not trigger the shutdown mode. Note (**) If the CAN bus disconnction is restored, the unit recovers and resumes normal operation immidiately.

Prevent CAN bus ALL STOP: ☐ (no shutdown mode if checked)

The CAN bus has an integrity check feature, where the bus is monitored. If a CAN disconnection is detected, all the relays are de-energized.
If this behavior is not desired, and the unit should not go into shutdown mode, check the button to disable this 'All Stop' feature.

CAN Bus Control:

The IOCOMx can be driven from the CAN bus by external (auxilliary) CAN devices. It responds to commands issued from the CAN bus. There is also a CAN 'bridge' mode where the CAN commands operate the remote relays. If and when this checkbox is checked, all external (aux) CAN operations are disabled.

For more information on the CAN external CAN bus operation please see the IOCOMx product manual or look at the Akostar CAN control examples on github or the relevant sections of the Akostar Web site.

Disable external CAN bus Control: ☐ (no can control if checked)

Save Configuration

The IOCOMx can be controlled from an external CAN bus. It is enabled by default. This setting will disable it.

This part of the page was left blank intentionally

Modes screen shot

Receiver Logic Selection:

Outputs 1 and 2 (Group 1):

- ⦿ Momentary
- ○ Pri. Interlock
- ○ Delayed Timed-Off
- ○ Delayed Hold Timed-On

- ○ Toggle
- ○ 1on / 1off
- ○ Delayed Hold Timed-Off
- ○ Local Relay

- ○ Interlock
- ○ 2on / 2off
- ○ Delayed Time-On
- ○ Disabled

Outputs 3 and 4 (Group 2):

- ⦿ Momentary
- ○ Pri. Interlock
- ○ Delayed Timed-Off
- ○ Delayed Hold Timed-On

- ○ Toggle
- ○ 1on / 1off
- ○ Delayed Hold Timed-Off
- ○ Local Relay

- ○ Interlock
- ○ 2on / 2off
- ○ Delayed Time-On
- ○ Disabled

Outputs 5 and 6 (Group 3):

- ⦿ Momentary
- ○ Pri. Interlock
- ○ Delayed Timed-Off
- ○ Delayed Hold Timed-On

- ○ Toggle
- ○ 1on / 1off
- ○ Delayed Hold Timed-Off
- ○ Local Relay

- ○ Interlock
- ○ 2on / 2off
- ○ Delayed Time-On
- ○ Disabled

Outputs 7 and 8 (Group 4):

- ⦿ Momentary
- ○ Pri. Interlock
- ○ Delayed Timed-Off
- ○ Delayed Hold Timed-On

- ○ Toggle
- ○ 1on / 1off
- ○ Delayed Hold Timed-Off
- ○ Local Relay

- ○ Interlock
- ○ 2on / 2off
- ○ Delayed Time-On
- ○ Disabled

[Save Configuration]

All the relays / outputs default to momentary mode. This is when the user presses the button, and the relay closes, the user releases a button and the relay opens.

The toggle mode is also a frequently used one. This is where one press / release cycle turns the button on, and the next press / release turns the button off.

Timed-Off / Timed-On Timings:

If the IOCOM8 transceiver group is set to TimedOff mode, these are the corresponding timing values on a per output basis. Time is specified in seconds; for example the value 90 will specify one an a half minutes. The smallest delay is one second, there is no limit placed on the largest delay.

Outputs 1 and 2:

Timeout 1: [1] sec   Timeout 2: [1] sec

Outputs 3 and 4:

Timeout 3: [1] sec   Timeout 4: [1] sec

Outputs 5 and 6:

Timeout 5: [1] sec   Timeout 6: [1] sec

Outputs 7 and 8:

Timeout 7: [1] sec   Timeout 8: [1] sec

[Save Configuration]

Here the delays are configured to one second, to allow quick testing of the functionality.

IOCOMx Transceiver; Advanced Settings

Receiver Configuration:

 The IOCOMx transceiver controls momentary switches by default. The control may be configured to respond in different manners, one pair/group at the time. The grouping is maintained in pairs, for instance group one is Input one and Input two -- with: Relay one and Relay two.

Receiver Logic Selection

 The receiver can respond to button presses with a variety of actions. These actions depend on the mode that is set on that configuration page. There are a multitude off modes available, below, is a list of the currently available modes. [Please note that the term relay on / closed is used for 'relay energized' and relay off / opened is used for relay 'de-energized'; The words button / switch / input are used interchangeability, denoting user input]

Receiver Logic Selection list:

 The following modes are available:

Momentary	Toggle	Interlock
Pri. Interlock	1on / 1off	2on / 2off
Delayed Timed-Off	Delayed Hold Timed-Off	Delayed Time-On
Delayed Hold Timed-On	Disabled	

Modes Description

a.) Momentary:

 When a Button is pressed, the corresponding Relay is closed, when the Button is released, the Relay opens.

b.) Toggle:

 When a Button is pressed the Relay closes, when a Button is pressed again, Relay opens.

c.) Interlock:

Only one of the group outputs are active at any one time; if both Inputs are present, no output is on.

d.) Pri. Interlock: (Priority interlock)

 Only one of the group outputs are active at any one time, if a second Input becomes active, the output which is already active has priority and stays on.

e.) 1on1off:

Button 1 of the group turns the Relay on, Button 2 of the group turns the Relay off.

f.) 2on2off:

Button one and two pressed together turns on Relay 1 and Relay 2; Button one and two pressed together again turns the Relay off.

g.) On Timed Off:

The Buttons turn the corresponding Relay on, and after a set amount of time, the Relay automatically turns off. The delay time can be specified below, individually on a per Input basis.

h.) On Hold Timed Off:

The Button turns the corresponding Relay on, and on Button release, the hold timer starts, which holds the Relay for a specified amount of time. after which, the Relay automatically turns off.

i.) Timed ON:

When a button is pressed, a timer starts. When the timer is expired, the corresponding Relay will close.

j.) Hold Timed On:

Button is pressed, and then, when released a timer starts. After the timer is expired, the corresponding Relay will close.

k.) Disabled:

The corresponding group's Relays will not activate;

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Timed-Off / Timed-On Timings:

If the IOCOMx transceiver group is set to TimedOff mode, these are the corresponding timing values on a per output basis. Time is specified in seconds; for example the value 90 will specify one an a half minutes. The smallest delay is one second, there is no limit placed on the largest delay. Following, is the default timeout setting:

Outputs 1 and 2:	*Timeout 1: One sec*	*Timeout 2: One sec*
Outputs 3 and 4:	*Timeout 3: One sec*	*Timeout 3: One sec*
Outputs 5 and 6:	*Timeout 5: One sec*	*Timeout 6: One sec*
Outputs 7 and 8:	*Timeout 7: One sec*	*Timeout 8: One sec*

Re-trigger Settings

If a group is set to 'Delayed Timed On' or 'Delayed Timed Off' mode, the individual Inputs can be configured to re-trigger. This way the duration of the timer can be extended during the hold interval. When the Output's box is checked, the timing delay of the Output is **expanded** like a new timer cycle is started. The re-Trigger mode defaults to OFF, the timer is unaffected by successive button presses.

Outputs 1 and 2:	*Re-trigger 1: disabled*	*Re-trigger 2: disabled*
Outputs 3 and 4:	*Re-trigger 3: disabled*	*Re-trigger 4: disabled*
Outputs 5 and 6:	*Re-trigger 5: disabled*	*Re-trigger 6: disabled*
Outputs 7 and 8:	*Re-trigger 7: disabled*	*Re-trigger 8: disabled*

Web Page footers

The web page footers contain useful information about the device itself. The MAC address acts as a globally unique identifier. The Software Version / Build date identities the firmware used in this device. The footer also contains the boot count of the device, which signifies how many times the unit was power cycled.

ID (Main) (Mac Address): 98:cd:ac:65:7a:15
Current Boot Count: 5
Software Version / Build Date: 1.0 Fri 20.Aug.2021
Akostar Inc, (C) 2021

The Command Line

   The IOCOMx has a serial port on board, that may be used to monitor, configure and operate the device. There is a mirror of all the web functionality, as well as additional commands. Some commands have aliases, which are listed with the command.

The following commands are available:

Command	Function	Description	Notes
ord, ordinal,	The position in the stack of CAN connected devices.	0 = No other device, in standalone operation 1-8 Position on the stack	
show	Show paired items		Mac address of the units paired (see id command)
list	List mode names and mode numbers		Configuration helper
pair	Start the pairing process		15 sec timeout, or successful pair; whichever comes first
stat, ls,	Show device's status and configuration	Some testing related items shown as well	
Conf	Show device's configuration	Ordinal, mac,	
reboot	Reboot device		Resumes normal operations in appx 800ms
web	Start configuration web server		Identical to the four button press action
mode	The output modes	Four groups of two relays	See 'Modes' section for more information
txrx	Toggle TX / Rx flag	Allow RF transmission; one unit per stack	At least one unit of the stack in TxRx mde
trig	Re trigger if button pressed while in operation	Defaults to OFF	
verbose, v	Control the amount of information that goes to the terminal		0=none 1=some (default) 2-9=more info, higher numbers are noisy
Allon, alloff	Switch all relay on / all relays off	Mainly for testing	Reboot erases the effect (all starts with off)

The mode and stat commands

Stat

Issuing the stat command results in the following output:

```
TX params:      Repeat Interval: 300 ms
                Repeat count:    3 times
                RF Power:        20 dBm
                TxRx function:   1
                Ordinal number:  8
                My pairing val:  ac:65:7a:15
Modes:          Group=0  Mode=1  ->  'Momentary'
                Group=1  Mode=1  ->  'Momentary'
                Group=2  Mode=1  ->  'Momentary'
                Group=3  Mode=1  ->  'Momentary'
Timeouts:       ch0=1sec   ch1=1sec   ch2=1sec   ch3=1sec
                ch4=1sec   ch5=1sec   ch6=1sec   ch7=1sec
ReTriggers:     ch0=0      ch1=0      ch2=0      ch3=0
                ch4=0      ch5=0      ch6=0      ch7=0
```

Please note that the mode lines are zero based on the command line, one based on the web interface. The web interface was crafted to address non technical users, the command line addresses reality as it is.

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Mode

The mode command with no arguments yields the following output:

```
Current modes:
     Group=0  Mode=1  ->  'Momentary'
     Group=1  Mode=1  ->  'Momentary'
     Group=2  Mode=1  ->  'Momentary'
     Group=3  Mode=1  ->  'Momentary'
```

To change a mode, one specifies the group number and the mode number. The mode number can be derived from the table that is presented by the 'list' command.

```
List of modes:
    Mode= 1  ->  'Momentary'
    Mode= 2  ->  'Toggle'
    Mode= 3  ->  'Interlock'
    Mode= 4  ->  'Pri. Interlock'
    Mode= 5  ->  '1on / 1off'
    Mode= 6  ->  '2on / 2off'
    Mode= 7  ->  'Delayed Timed-Off'
    Mode= 8  ->  'Delayed Hold Timed-Off'
    Mode= 9  ->  'Delayed Time-On'
    Mode=10  ->  'Delayed Hold Timed-On'
    Mode=11  ->  'Local Mode'
    Mode=12  ->  'Disabled'
```

For example, to change the mode of group 0 to 'toggle' issue the following:

mode 0 2

To change all group modes '2 on 2 off' issue the following commands:

mode 0 6
mode 1 6
mode 2 6
mode 3 6

The mode commands take effect immediately, and remembered across boots permanently, until explicit change.

The Command Line, test and misc. items

The IOCOMx has a serial port on board, that may be used to monitor, configure and operate the device. The following commands are available:

Command	Function	Description	Notes
erase	Manufacturer's reset		Restores original state
dumb	Switch the terminal to dumb mode	The serial port cal also act as a device control	This removed the escape sequences from the communication for machine controllable input.
dump, candump,	Show device and CAN bus details		obsolete
allanim	Turn relays on sequentially, then off sequentially		Mainly for testing
monin	Monitor input	Prints a list of switch states on the controlling terminal	Does not prevail on device reboot
cango, cango2,	Show CAN bus activity on debug terminal	For use with debug and troubleshooting	cango for receive operations and cango2 for send operations
in2out	Switch the in to out node on	Button presses are mirrored onto the relays	Resets to normal mode on reboot, does not prevail.

System Commands

The system commands are not essential to everyday operations, however they are kept in case for further troubleshooting.

Command	Function	Description	Notes
free	Show available memory	Memory level	
heap	Show min available memory	Low watermark	
version	Chip used		
restart	Same as the reboot		Issued at chip level
tasks	Task currently running	Show system details	Internal

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The CAN bus

The IOCOMx devices individually can control up to eight I/O ports (relays). In order to control more ports, one may chain them into a larger set via the built in CAN bus.

Ports: 1-8	Ports: 9-16	Ports: 17-24	Ports: ...
IOCOMx#1	IOCOMx#2	IOCOMx#2	IOCOMx#...
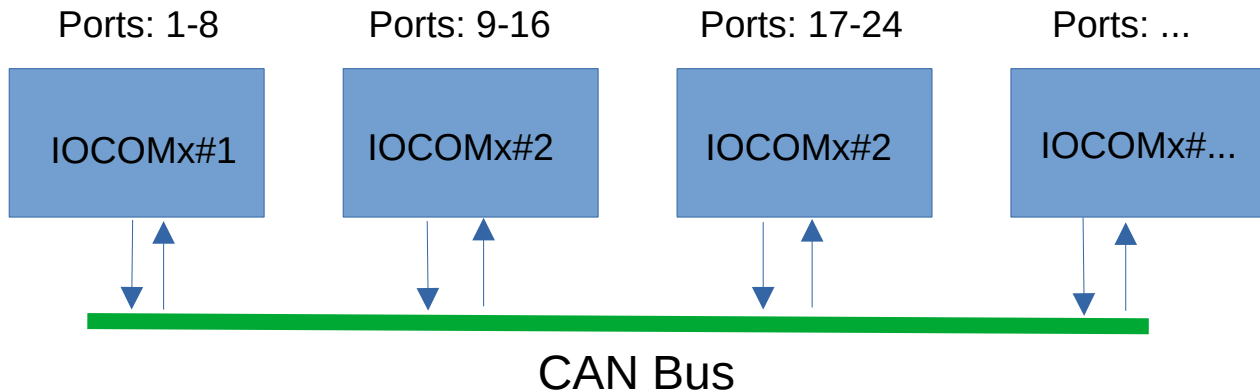
CAN Bus

The IOCOMx built in CAN bus may connect multiple IOCOMx devices to send receive data for up to 64 channels. (eight units) The IOCOMx devices must be configured to cooperate on the bus. They all have to have a unique Ordinal, and one - and only one – unit has to be marked as the TxRx unit. If these criteria are not met, the CAN LED will light up in an error sequence.

CAN Controls

The IOCOMx system relies on the build in can bus to connect multiple IOCOMx devices to send receive data for all 64 channels. The CAN will detect mis-configuration and alerts the user if:

- No IOCOMx module is marked as TxRx unit
- More than one module is marked as TxRx unit on the same bus
- More than one IOCOMx module occupies the same ordinal

If the CAN bus detects any of these errors, the CAN LED is on for a longer duration, and blinks OFF for a short period of time. This pattern is different from normal operation, as the normal operation is short on and longer off. Additionally, the error condition is shown on the configuration web page, as well as a command line message is issued on the controlling terminal.

The CAN bus, default functions

The CAN bus communicates between the IOCOMx devices. In its idle state (Ordinal 0) no communication takes place. If the Ordinal is not zero, the CAN bus emits a heartbeat, verifying the integrity of the connected IOCOMx configurations.

External CAN Control

The CAN bus can control all the relays, both local and remote. The control message IDs are:

```
MSG_RELAYS      0x19EE5503  // Control local relays
MSG_BRIDGE      0x19EE5504  // Control remote relays (note: timeout)
```

The data format of the control is the standard 8 bytes, with extended message ID and 250 KBit bus speed. The first four bytes of the data are significant. The second four bytes may contain arbitrary values.

BYTE POSITION	DESCRIPTION	NOTES
Byte_0:	Bit Mask of the Switches	0 = OFF ; 1 = ON In many places this is called the payload
Byte_1:	Bit Mask of Controls	Which bits to operate on; ex: 0xFF means operate on all bits. The bit mask allows control from multiple sources.
Byte_2:	Ordinal	Address of the board; values are 1-8, all other values are discarded as invalid data
Byte_3:	Checksum	Byte_0 XOR 0x55 – Packets that have invalid checksum are discarded.

Multi control conflicts

The IOCOMx can be controlled from multiple sources. The bit mask allows to operate on specific bits at a time. For instance, the mask 0xF0 operates on the bits 4-7, and the mask 0x0F operates on bits 0-3. It is perfectly normal, - for example - to control some bits from CAN and some bits from RF.

In the IOCOMx, there are no arrangements made to coordinate controls, every command is obeyed from every source. It is the user's (installer's) responsibility to coordinate this control. The general rule of control effect is that the last control prevails. For instance switching an output ON from RF, and then switching the same output OFF from CAN, will result in the last controlled state prevailing.

In general, the order of switching (and control) is decided by the control equipment that is attached to the IOCOMx. It is the user's and installer's sole responsibility to maintain safe operation, hereby, all liability is disclaimed for the operation IOCOMx.

Reading / Writing to the CAN bus

The IOCOMx's CAN interface can receive instructions and control commands from the CAN bus, as well as emit switch information and emit relay information.

The IOCOMx attempts to be a standards compliant. The CAN bus's bit rate is 250 KBits, and the transmissions are 8 bytes long. The general format of the CAN bus transaction uses the the first four bytes (32 bits) as a bitmap to the specific operation.

Controlling local relays (outputs) from the CAN bus

One can control the local relays from the CAN bus. Send data to the CAN bus consisting of the output bits, output bit mask and the ordinal number of the unit.

The bit mask determines the scope of the control. Only the bits that are set to one are allowing bit change by the payload. All the other bits are ignored. For instance, to set relay 1, one sends the bit mask of 1, and the actual (payload) bit to 1. To reset this same bit, send the bit mask of 1, and the payload to zero (0); All the other bits are unaffected. This system allows arbitrary bit operation from multiple sources. Please note, that if multiple sources control the same bit, the last operation prevails.

Controlling remote relays (outputs) from the CAN bus

One can control the *remote* relays from the CAN bus. This is done in a similar fashion as the local relay control. One sends data to the CAN bus consisting of the of the output bits, output bit mask and the ordinal number of the unit.

IOCOMx CAN bus control via the supplied sample program

The sample program (supplied via the web) shows an example of the IOCOMx CAN bus control. The program exercises most the external functionality of the IOCOMx CAN interface.

```
Akostar CAN test utility. (C) Akostar Inc; See README for copying.
Use: robotell.py [options] bits masks ord [ ... bits masks ord ]
   Where options can be:
     -V          --version    print version
     -h          --help       print help
     -c          --devices    print supported devices
     -t          --timing     show timing
     -i          --interface  interface board (default: robotell)
     -l          --listen     listen
     -g          --bridge     bridge
     -v          --verbose    verbose
     -p  port    --port       serial port (def: /dev/ttyUSB0)
     -b  bitrate --bitrate    bit rate (def: 250000)
     -i  message --message    message id (def=0x19EE5504 )
     -d  level   --debug      debug level
```

```
Arguments for short options also needed for the long options.
Use '0x' as hex prefix or '0y' or '0b' as bin prefix.
```

CAN Bus conflicts

   With the exception of the TxRx unit, he CAN bus receives all communications from all devices, and drives the cooperation between these controlling entities. One may control the system from: a.) The local input b.) Local input via the CAN bus, c.) Remote input via RF d.) An external CAN controller.

   The bit mask mechanism gives a distinct scope of control. With the bit mask, one can specify which bits have permission(s) to which subsystem. However, there is no mechanism to filter out control from multiple devices, with possible overlapping bit masks. It is the user's responsibility to filter out bit mask conflicts.

   If the IOCOMx system receives conflicting information with overlapping bit masks, it will execute the commands in the order they arrive. For instance, device 'A' switches relay ONE on, device 'B' switches relay ONE off, the IOCOMx will follow both switching instructions. This results in the unexpected OFF state from device 'A'-s perspective. This phenomena is expressed in simple terms of: first come first served; last come, last prevails. This description of operation also serves as a *disclaimer*: the installer / operator assumes all responsibility for the operation of the device.

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IOCOMx CAN bus control via the GUI sample program

 The GUI sample can be found at https://github.com/akostarinc/IOCOM8-Support/tree/main/CAN/gui named rtellgui.py. Below, a screen shot of the program, which can be used to control all 64 relays on both the local boards, and (with a checkbox checked, the remote boards). [Remote boards here are interpreted as the boards that are connected by RF to these boards]

 The rtellgui.py contains many functions that can be driven from the command line.

```
Usage: rtellgui.py [options]
Options:

   -d level   --debug    Debug level 0-10   0 = None; 10 = Noisy;
   -p port    --port     Serial Port to use. Example: /dev/ttyUSB0
   -v         --verbose  Verbose.  Print some useful event info.
   -b         --bridge   Verbose.  Print some useful event info.
   -V         --version  Print version info.
   -q         --quiet    Quiet. Do not print much to the console.
   -h         --help.    This message
```

Advanced CAN functions

The CAN bus exposes most of its inter-board communications. One can intercept input (switch) change information and output (relay) change information. The exception to the role is the TxRx unit, which does not expose any of its internal workings on the CAN bus, as the TxRx unit processes its operations internally.

The following CAN massages contain useful, observable information:

```
MSG_SWITCHES    0x19EE5501  // Intra IOCOMx msg to funnel to RF

MSG_RFTOCAN     0x19EE5502  // Intra IOCOMx msg via RF
```

Reading Switch information from the CAN bus

Every time the IOCOMx detects an input change in its I/O ports, it sends the unit's switch bit-mask and ordinal number to the CAN BUS. Reading this information from the CAN bus is just a matter of intercepting / filtering the 'MSG_SWITCHES' message.

Reading Relay information from the CAN bus

Every time the IOCOMx receives a relay status change from remote, it sends the current relay bit-mask to the CAN BUS. Reading this information from the CAN bus is just a matter of intercepting / filtering the 'MSG_RFTOCAN' message.

CAN bus external read examples:

The demo utility can be found at https://github.com/akostarinc/IOCOM8-Support/tree/main/CAN under the robotell subdirectory. This utility has a 'listen' option where the IOCOMx CAN bus may be monitored. It is up to the implementer to capture the messages and act on it.

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Terminology

The terminology in this manual reflects words used in the process of development. Other aspect of the deployment (ex: installation) may use a different terminology. This chapter attempts to clarify the intended meaning, and to further disambiguate.

Word	Intended Usage	Used interchangeably with	Notes
Relay	The on board relay	Output,	Dependent on context
IOCOMx	Identifies this device	IOCOM8	The root device is IOCOM8, it becomes IOCOMx when multiple devices are chained via the CAN bus.
Button / Switch	The input button	Input, Button, Switch, Input button	Dependent on context; these are voltage presence detection inputs, but the voltage presence originates via an outside button / switch.
Device	The device in context	IOCOMx, IOCOM8	IOCOM8 is the base unit, IOCOMx term is used when it is deployed in stack
Ordinal	The position in the IOCOM stack	Ord, device number	Only applicable in multi device configuration
CAN	The CAN bus		As used in industry standard descriptions
Relay ON	The state of the relay	Closed, Energized	Contacts in MAKE position
Relay OFF	The state of the relay	Opened, De-Energized	Contacts in BRAKE position
Control Button	The inputs to the device	Input, Button, Switch	See button / switch
Configuration button	The configuration button located on the side of the device	Config. Button	This is the multi press capability button.
Stack	More than one device connected by the CAN bus		2-8 devices
Unit	One IOCOMx device		
User / Installer	The entity that uses / owns / deploys the device, beneficiary of its services / utility.	Customer, Owner, User, Installer, Integrator, System Integrator	Legal entity that represents the device's ownership.

Disclaimer

The IOCOMx system device consists of several interconnected parts. Some parts communicate via a Wired bus, some parts communicate via Radio Frequency. While all efforts have been made to assure proper operation, due to the nature of technologies involved, Akostar Inc. only warrants operations that are within the limitations of the underlying technologies. It is the user's and installer's responsibility to operate the device safely.

The IOCOMx system may control equipment that is inherently dangerous. In that case, the user / installer is hereby advised to the complexity of the control, the possibility of multiple control sources, and conflicts thereof. Akostar Inc. explicitly denounces liability arising from the operation of the device.

The **sole remedy** of the user / installer is the repair / replacement of said device, at the option of the Manufacturer, Akostar Inc.

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