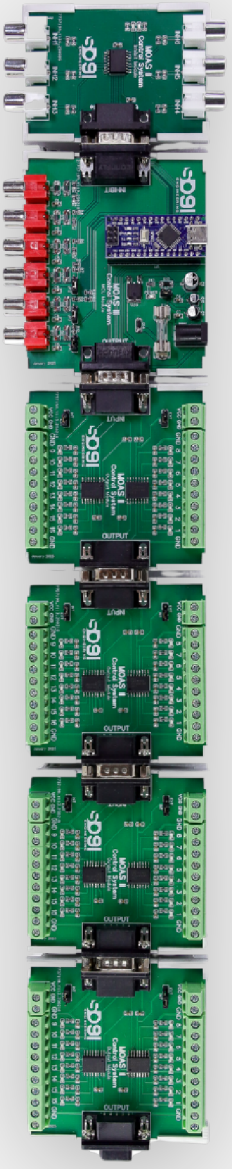
SO9I ENGINEERING

HARDWARE MANUAL · REV. 1.0

MOAS II

> Modular station automation hardware — MCU, output and inhibit modules

- MCU + up to 4× 16-Output Modules per set
- Positive or Ground-Switching Outputs, 5–50 V DC
- 6-Radio PTT / Inhibit Management
- DIN Rail Mounting



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SO9I ENGINEERING

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01 Introduction

The **SO9I Engineering MOAS II** is a modular hardware platform for automating antenna switching, band-pass filter selection, PTT management and other relay-controlled functions at a contest or DX station.

SO9I Engineering designs and manufactures the **hardware** only: a set of DIN-rail modules — an MCU (processor) module, 16-output relay-driver modules, and an inhibit module — that you combine to build a system sized exactly to your station. The **control software** is the original MOAS II Server/Client package created by **Paul, K1XM**, and is unchanged — see Section 11 for details and download links.

Typical Applications

- **Automatic antenna switching** — select the correct antenna output the instant your logging software reports a band change
- **SO2R and Multi-Operator stations** — coordinate two or more radios sharing antennas, with built-in conflict prevention
- **Band-pass filter and accessory switching** — drive relays in filters, rotators, or any other 12 V (or externally powered) accessory
- **Hot-switching and inhibit protection** — prevent antenna changes while transmitting, and block one radio from transmitting while another is on the air

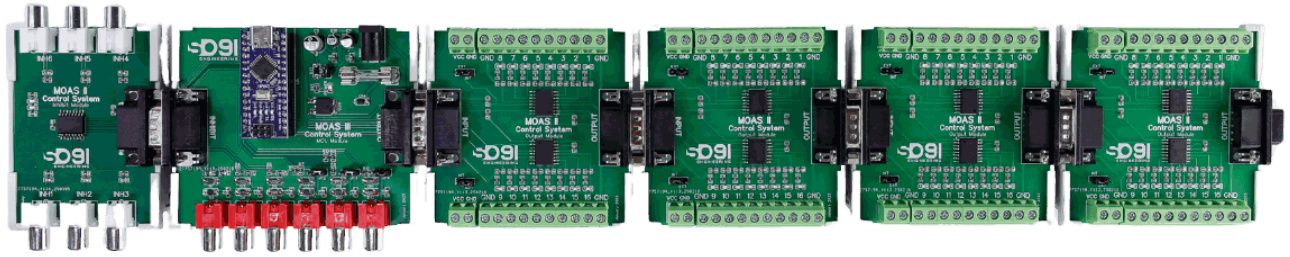
02 What Is MOAS II?

MOAS — the **"Mother of All Switches"** (also read as "Master of Antenna Switching") — is a station-automation concept originally developed by **Paul, K1XM**, and carried forward as a Yankee Clipper Contest Club (YCCC) project. Its purpose is simple: most contest and DX stations end up with a tangle of relays controlling antenna switches, band-pass filters and rotators, and MOAS automates all of it from a single, frequency-aware controller instead of requiring manual switching for every band change.

The **MOAS II** generation adds radio-inhibit management, high-side (positive-voltage) relay outputs, and a much more capable configuration language than the original MOAS.

SO9I ENGINEERING'S ROLE

SO9I Engineering did not create the MOAS II software — we manufacture a **modular hardware realisation** of it. Where the original K1XM/YCCC hardware is a small number of fixed boxes, our version splits the same electrical design into interchangeable DIN-rail modules (MCU, output, inhibit), so a station can be built with exactly the number of outputs it needs, and expanded later simply by adding more modules to the chain. The software running on the PC and controlling this hardware is **identical** to the standard MOAS II Server/Client package — no separate SO9I-specific software is required.



A typical set: Inhibit module — MCU module — four 16-output modules, chained left to right

03 System Architecture — Server, Client & Hardware

A MOAS II system has three layers working together. Understanding the split between them makes both the wiring in this manual and the software setup much easier to follow.

1. The Hardware (this manual)

The SO9I modules described here — MCU, 16-output, and inhibit — form the physical relay layer. It connects to the PC over USB, accepts PTT lines from your radios, and drives up to 64 relay outputs per MCU. It has no "intelligence" of its own beyond executing the commands it receives from the MOAS Server.

2. The MOAS Server (Windows PC)

The MOAS Server is Windows software that holds the station's configuration: every antenna, filter and relay in your shack, which relay combination corresponds to which antenna, and which combinations conflict with each other (for example, two radios that must never be connected to the same antenna at once). It talks to the MCU module over USB and drives the relays according to that configuration.

3. The MOAS Client(s)

One MOAS client application runs per operating position (or per logging PC). It reads the currently active frequency from your contest logging software — DXLog.net, N1MM+, Win-Test, WriteLog and others are supported — via CAT control, and reports it to the Server. The Server then works out which relays that band change requires and switches them automatically, with no manual action from the operator.

🔀 Automatic Band-to-Antenna Mapping

Change bands in your logging software (or on the radio) and the correct antenna, filter and rotator relays switch automatically — no dedicated antenna-switch box-turning required.

🛑 Hot-Switching Protection

The MCU module reads PTT from each connected radio. The Server will not command a relay change on a port that is actively keyed, preventing switching under load.

🚫 Inhibit / Anti-Collision

For multi-radio stations, the Server can block a second radio from transmitting while another is already on the air, and can refuse to assign an antenna that another operating position is already using — both enforced through the Inhibit module.

🌐 Networked Multi-Position Setups

Multiple clients — one per operating position — talk to the same Server, so every position always sees an up-to-date, conflict-free picture of what the rest of the station is doing.

CONFIGURATION IS NOT PLUG & PLAY

Programming a MOAS II Server configuration file — describing your antennas, bands, relays and conflict rules — is a genuine setup task, not an automatic wizard. Budget real time for it when commissioning a new station, and start from one of the example configuration files supplied with the Server installer rather than from a blank file.

System architecture summary based on the official MOAS II documentation (Paul, K1XM — k1xm.org).

04 Technical Specifications

PARAMETER	VALUE
PC connection	USB-C (MCU module)
Input power	12 – 14 V DC, 5.5 / 2.5 mm barrel jack (MCU module)
Input fuse	1 A, fitted immediately after the DC input jack
PTT inputs	6, RCA, contact-closure to ground (TX GND from each radio)
Inhibit outputs	6, RCA, +12 V through a 10 kΩ series resistor when active
Output modules per MCU	Up to 4 (16 outputs each) = 64 outputs per MCU
Output type — Positive module	Switched positive voltage, INT (12–14 V from MCU) or EXT (5–50 V DC), selectable per 8-output bank
Output type — Ground module	Switched ground; outer terminals supply +12–14 V from the MCU
Max. current per output	400 mA
Max. current per 8-output bank	900 mA
Inter-module connector	DB9, direct plug-to-plug — modules mate directly, no cable between them
Mounting	35 mm top-hat DIN rail (EN 60715 / TS35), each module has its own DIN clip
Status indication	1 LED per output, on every 16-output module (positive and ground)
Control software	MOAS II Server (Windows) + MOAS Client(s) — by Paul, K1XM, unmodified

05 Module Overview

Every MOAS II hardware set is built from four module types, each on its own DIN-rail clip-on board. Mix and match them to fit your station:

🧠 MCU Module

The processor module. One per system. Connects to the PC via USB-C, accepts 12–14 V DC power, and reads up to 6 PTT inputs. Distributes power and data to every other module in the chain.

＋ 16-Output — Positive

Switches positive voltage onto 16 individually controlled outputs, split into two independent 8-output banks. Ideal for driving relay coils, filters, and other positive-triggered accessories.

⏚ 16-Output — Ground

Switches ground (GND) onto 16 outputs instead of positive voltage — for accessories that expect a ground-switched control line rather than a positive one.

🚫 Inhibit Module

Provides 6 configurable inhibit outputs used to block a radio from transmitting, preventing conflicts between radios sharing a station.

Chain Order

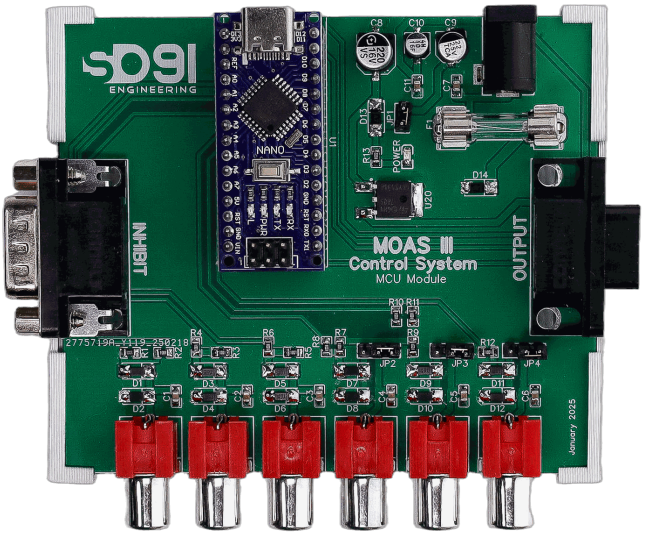
Modules are always assembled in the same order, reading left to right: the **Inhibit module** connects to the MCU's left-hand DB9 port, and up to **four 16-output modules** (positive, ground, or a mix of both) chain off the MCU's right-hand DB9 port, each module's *OUTPUT* port feeding the next module's *INPUT* port.

NOTE

Modules connect directly to each other — the DB9 plug on one module mates straight into the DB9 socket on its neighbour, with no cable in between. No internal wiring or pin-mapping is needed between modules. Positive and ground output modules can be freely mixed within the same 4-module chain, in any order, to match whatever combination of relay types your station requires.

06 MCU Module

The MCU module is the brain of the system, built around an Arduino Nano. It is the only module that connects to the PC, and the only one that needs its own power supply — every other module in the chain is powered through it.



MCU module — USB-C and DC power on the left, PTT inputs along the bottom, Inhibit (left) and Output (right) DB9 ports

Connecting to the PC

Connect a USB cable from the MCU module's **USB-C** jack to the computer running the MOAS Server software.

> **RF ENVIRONMENT TIP**
>
> This USB link runs next to live transmitters. Fit **ferrite cores** on the USB cable close to both ends — the usual practice for any data or control cable at a contest station — to keep RF from the transmitted signal out of the USB link.

Power Supply

Connect a regulated **12–14 V DC** supply to the MCU's DC barrel jack (5.5 / 2.5 mm). This is the only power connection needed for the whole chain: the MCU distributes it to every connected module, and also derives the other internal supply voltages (such as 5 V for the logic) that the modules need. A **1 A fuse**, fitted immediately behind the DC jack, protects the whole set.

This same 12–14 V rail is what appears on an output module's terminals when that module's INT/EXT jumper is set to **INT** (see Section 7).

PTT Inputs (RCA1 – RCA6)

The six RCA jacks along the bottom edge accept a **TX GND** signal from up to six independent radios — the PTT line is read as active when the jack is shorted to ground. Numbering runs left to right, RCA1 through RCA6.

PTT Jumpers — Independent vs. Bridged Inputs

Three jumpers, positioned next to RCA4, RCA5 and RCA6, control whether the right-hand three PTT inputs are independent or bridged to their left-hand counterpart. Each of the three pairs can be set independently.

JUMPER POSITION	EFFECT
Left + centre pins	That pair's two jacks are independent — 6 separate PTT inputs when all three jumpers are in this position
Right + centre pins	That pair is bridged: RCA1↔RCA4, RCA2↔RCA5, or RCA3↔RCA6 (per jumper) — the two jacks read as a single PTT input

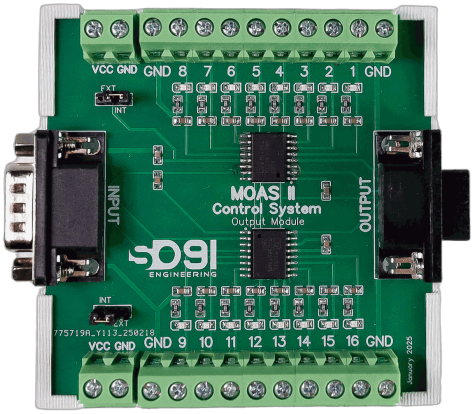
Use the bridged position when a single radio's PTT needs to be wired to two separate cables (for example, feeding both the MOAS inhibit logic and another accessory from one PTT source) without a Y-splitter.

DB9 Ports — Inhibit and Output

- **Left DB9 (INHIBIT)** — connects to the Inhibit module
- **Right DB9 (OUTPUT)** — connects to the first 16-output module in the chain; up to 4 output modules can be chained from this single port

07 16-Output Module — Positive Voltage

This module switches positive voltage onto 16 individually controlled outputs, arranged as two independent banks of 8: outputs **1–8** along the top edge and **9–16** along the bottom edge. On each bank, the outermost terminal at each end is a **ground (GND)** reference terminal.



16-output module — INPUT (left) and OUTPUT (right) DB9 chain ports; VCC/GND and INT/EXT jumper visible at each end of both terminal rows

Powering the Outputs — INT / EXT Jumper

Each 8-output bank has its own **VCC / GND** terminal pair and its own **INT / EXT** jumper, set independently of the other bank on the same module:

- **INT** — the bank is powered from the 12–14 V DC supplied to the MCU module
- **EXT** — the bank is powered from an external supply wired to that bank's own VCC/GND terminals, anywhere in the **5–50 V DC** range

Use EXT when an accessory needs a voltage other than the MCU's 12–14 V supply — for example, driving 24 V or 48 V relays directly from the module, without an external relay driver board.

> ⚠ **CURRENT LIMITS**
>
> Do not exceed **400 mA on any single output**, or **900 mA total across one 8-output bank**. These limits apply per bank (1–8 and 9–16 separately) — driving several outputs on the same bank simultaneously, add up their currents against the 900 mA bank limit.

Status LEDs

Each of the 16 outputs has its own status LED, lit whenever that output is active — a quick visual check of exactly which relays are energised without needing to probe the terminals or check the Server.

Chaining

Connect the module's **INPUT** (left) DB9 port to the MCU (or to the previous module's OUTPUT port), and its **OUTPUT** (right) DB9 port to the next module's INPUT port, if any. Up to 4 output modules — positive, ground, or mixed — can be chained from one MCU.

08 16-Output Module — Ground Switching

This module switches 16 individually controlled outputs to **ground**, arranged as two independent banks of 8: outputs **1–8** along the top edge and **9–16** along the bottom edge. On each bank, the outermost terminal at each end is a **VCC** terminal — the 12–14 V DC supply forwarded from the MCU module, provided there for convenience when wiring an accessory.

How the Outputs Work

Each output is an **NPN transistor switch** (open-collector), not a mechanical relay contact. When active, it pulls that output down to ground; when inactive, it is left open. This is meant purely to interface with a control or sensing input on an accessory — for example, an amplifier's or switch's ground-triggered keying/PTT input — not to switch power to a load directly.

Powering the Module

The module is always powered from the MCU's 12–14 V DC supply — there are no external-voltage terminals and no INT/EXT jumper on this module (unlike the positive module in Section 7). If an accessory needs its own separate supply voltage on the line it's connected to, use the positive module with its EXT jumper instead.

> ⚠ **CURRENT LIMITS**
>
> Do not exceed **400 mA on any single output**, or **900 mA total across one 8-output bank**. These limits apply per bank (1–8 and 9–16 separately) — driving several outputs on the same bank simultaneously, add up their currents against the 900 mA bank limit.

Status LEDs

Each of the 16 outputs has its own status LED, lit whenever that output is active — a quick visual check of exactly which outputs are switched without needing to probe the terminals or check the Server.

Chaining

Connect the module's **INPUT** (left) DB9 port to the MCU (or to the previous module's OUTPUT port), and its **OUTPUT** (right) DB9 port to the next module's INPUT port, if any — see Section 10 for how modules physically connect to each other. Up to 4 output modules — positive, ground, or mixed — can be chained from one MCU.

> **WHEN TO USE THIS MODULE**
>
> Choose the ground-switching module for accessories that expect their control line pulled to ground to activate (a common requirement for PTT-style inputs on amplifiers and some antenna switches), rather than a positive voltage. Positive and ground modules can be freely mixed in the same 4-module output chain.

09 Inhibit Module

The Inhibit module blocks a radio from transmitting — used to prevent two or more radios sharing a station from transmitting at the same time, a common requirement in Multi-Operator and SO2R setups.

Inhibit module — six configurable RCA outputs (INH1–INH6) and a single DB9 port to the MCU module

How It Works

The module provides **6 configurable outputs** (INH1–INH6), matching the MCU's 6 PTT inputs one for one. When the MOAS Server decides a given radio must be blocked from transmitting, the corresponding RCA jack is driven to **+12 V through a 10 kΩ series resistor**. Wire this output into the inhibit/lockout input of the radio (or amplifier) that needs to be blocked.

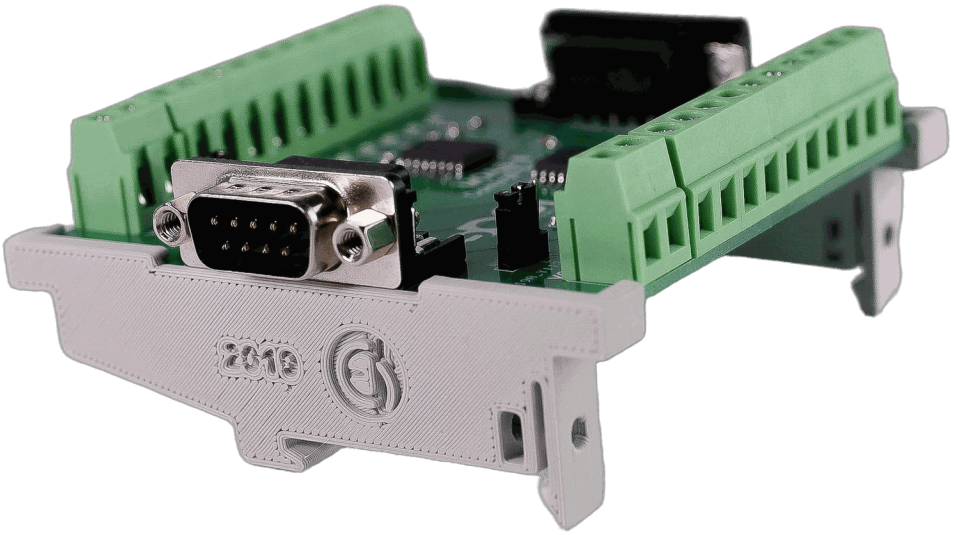
Connecting to the MCU

Plug the Inhibit module's single DB9 port directly into the MCU module's **left-hand (INHIBIT)** DB9 port — the two connectors mate directly, with no cable in between.

> **NOTE**
>
> Which radios get inhibited under which conditions is defined entirely in the MOAS Server configuration — the Inhibit module itself has no logic of its own, it simply exposes 6 driven outputs under the Server's control.

10 Assembling the Chain & DIN Rail Mounting

Every module clips onto a standard 35 mm top-hat DIN rail via a moulded plastic bracket on its underside — the same rail used throughout industrial control cabinets, so any standard DIN rail segment long enough for your module count will do.



DIN rail clip on the underside of a module — clips directly onto a standard 35 mm top-hat rail

Assembly Order

1. Clip the **Inhibit module** onto the left end of the rail.
2. Clip the **MCU module** immediately to its right, pushing it in until its left DB9 (INHIBIT) plug mates directly with the Inhibit module's DB9 socket — no cable is used.
3. Clip your **16-output modules** (positive, ground, or a mix) in sequence to the right of the MCU, pushing each one against its neighbour so its INPUT DB9 plugs directly into the previous module's OUTPUT DB9.
4. Power the MCU module last, once every module is clipped in place and every DB9 connector is fully mated with its neighbour.

INSTALLATION TIP

Build the full chain on the bench and confirm it enumerates correctly in the MOAS Server before mounting the rail permanently in the shack — it is far easier to check every DB9 connection while the modules are still laid out flat than after they are clipped into a rack or cabinet.

⚠ POWER DOWN BEFORE RECONFIGURING

Disconnect the DC power supply before adding, removing, or re-seating any module. Hot-plugging modules is not supported.

11 Software & Support

SO9I Engineering's MOAS II modules run the standard, unmodified MOAS II Server and Client software written and maintained by **Paul, K1XM**. Download the installer, manuals and configuration examples directly from his site:

> **k1xm.org/Antenna_Switch/MOAS_II**

The download page includes the Windows installer (Server, Client, rotator control and an emulator for testing without hardware connected), the printed manuals, and firmware for the hardware's microcontroller.

> **ACTIVELY MAINTAINED**
>
> Paul, K1XM continues to actively update the MOAS II software — new features are added on an ongoing basis — and he is genuinely responsive to questions and requests to adapt the software to a specific station's needs. If you run into a configuration question the manuals don't answer, reaching out to him directly is a good next step.

Real-World Example

For a detailed, real-station account of MOAS II in daily contest use — including a Multi-Single setup switching 55 relays across several layers of antenna and filter switching — see the SZ1A station write-up:

> sz1a.org — "The Mother of All Switches (MOAS II) Is Here!"

Hardware Support

For questions about the SO9I modules themselves — wiring, module counts, power supplies, or a custom configuration of positive/ground output modules — contact SO9I Engineering directly at **info@so9i.com**.

12 Troubleshooting

SYMPTOM	POSSIBLE CAUSE	ACTION
MCU not recognised by PC	USB cable or driver issue	Try a different USB cable/port; confirm the Arduino Nano's USB driver is installed
Whole set unpowered	Blown 1 A input fuse	Check the fuse next to the MCU's DC jack; check for a short before replacing it
One output bank dead, rest of module fine	INT/EXT jumper set to EXT with no external supply connected	Check that bank's VCC/GND terminals for an external supply, or set the jumper to INT
Output modules beyond the first don't respond	A module is not fully seated against its neighbour	Check every INPUT↔OUTPUT DB9 pair in the chain, module by module from the MCU outward, and push each pair fully together
PTT not detected from a radio	Wrong PTT jumper position, or wiring fault	Confirm the RCA1–3 / RCA4–6 jumper is in the position matching your wiring (Section 6)
Radio still transmits despite inhibit	Inhibit wiring or Server configuration issue	Verify the Inhibit module's RCA output reaches the radio's inhibit input, and check the MOAS Server configuration for that radio
Relay chatters or resets under RF	RF getting into the USB link	Add ferrite cores to the USB cable near both ends

13 Safety Notes

⚠ POWER DOWN BEFORE WIRING CHANGES

Always disconnect the DC power supply before connecting, disconnecting, or re-seating any module or output wiring.

⚠ CURRENT LIMITS

Never exceed 400 mA on any single output or 900 mA total on one 8-output bank. Exceeding these limits can damage the module and is not covered by support.

⚠ EXTERNAL VOLTAGE (EXT MODE)

When a bank's INT/EXT jumper is set to EXT, the module's outputs carry whatever external voltage is applied — up to 50 V DC. Treat the VCC/GND terminals and every output on that bank as live at that voltage, not at the MCU's 12–14 V level.

MODIFICATIONS

Do not open or modify the modules. Internal modifications will void support and may cause damage not covered under warranty.