MOTOROLA

# MOSCAD-L
## Product Planner

R4-11-1015A
March 1999

# TABLE OF CONTENTS

This page intentionally blank

# Foreword

This MOSCAD-L Product Planner is a supplement to the MOSCAD Product Planner. The reader is encouraged to read the MOSCAD Product Planner (R4-11-03) before continuing with this document. Descriptions common to both products are not repeated herein so the prior reading of the other document is important.

# MOSCAD System Overview

The purpose of a MOSCAD system is typically to provide some degree of automatic operation to a new or existing customer process. The process may be found in water pump stations, sewage lift stations, communication system monitoring, security, public notification control, electrical substation monitoring, distribution automation, demand-side management, automated meter reading, or other applications.

MOSCAD and MOSCAD-L may be intermixed in virtually all of these systems. MOSCAD-L is the littler and leaner member of the MOSCAD family and offers a limited selection of the Input/Output capabilities available with MOSCAD. Both products utilize the MDLC communications protocol.

A MOSCAD-L Programming ToolBox is available to ease the configuration and programming of this product. This variation of the MOSCAD ToolBox supports the unique modules and radios available with MOSCAD-L.

# MOSCAD-L RTU

Like MOSCAD, the MOSCAD-L RTU is a universal device that may serve as an RTU or a PLC. It is placed at the system's field sites to collect data from on-site sensors, add data from off-site sources, and use this data aggregate to make decisions regarding how some process is operating. The RTU may make changes to the local process; messages may be initiated that send data to MOSCAD or MOSCAD-L RTUs located elsewhere to influence the operation of off-site equipment or to advise the SCADA manager of some important change.

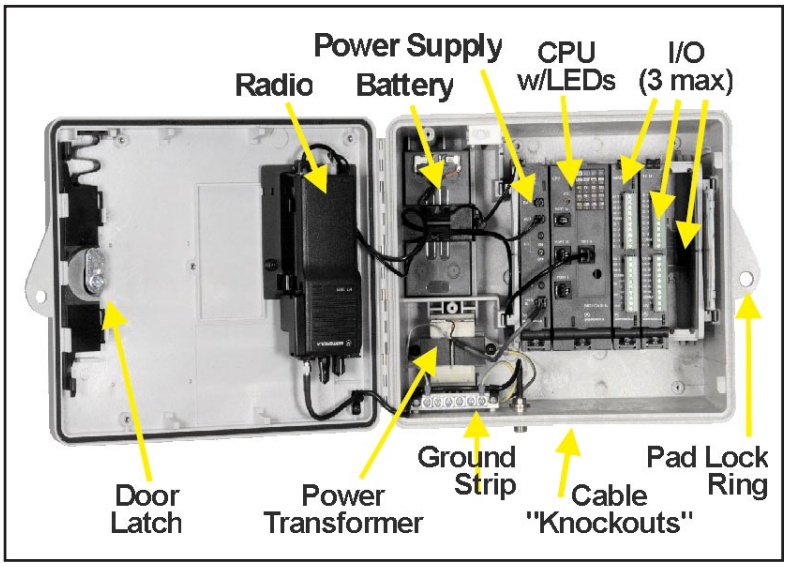



**Figure 1.** MOSCAD-L RTU

The RTU consists of a unique plastic enclosure that contains the module rack, battery, power transformer, and communications device (typically a two-way radio although the radio may be replaced with a wireline modem when that communication medium is desired.) The enclosure and module rack are integrated into an inseparable single entity; the module rack contains the power supply/charger module, the CPU module, and up to three Input/Output modules. The radio, when present, is attached to the door of the enclosure via a mounting plate; the Spread Spectrum radio is located inside the CPU module. The enclosure therefore unifies and protects all components of the MOSCAD-L RTU.

## Power Supply Module

The MOSCAD-L RTU uses a dual source of operating power. The primary power source is a power supply module that plugs into the left-most slot in the module rack; it is connected to the ac power mains through an off-module power transformer or directly connected to an external solar panel with associated voltage regulator and battery. The power supply module provides 5 Vdc, 14.3 Vdc and 24 Vdc to the other modules, the communication device, and to other active elements within the RTU. A secondary power source, namely a rechargeable 1.2 A-h battery, may also be present to power the modules, communication device, and certain other active elements of the RTU when the primary source of power fails. The battery is connected to these elements through the power supply module; the power supply module acts as the battery charger. The power supply module provides zero-transfer-transient performance.

Four options are available that permits the MOSCAD-L's power source to be tailored to the specific requirements of the site.

» The **V251 230 Vac option** replaces the standard 117 Vac power transformer with a transformer rated for 230 Vac 50 Hz input.

» The **V240 20-28 Vac/21-50 Vdc option** deletes the off-module power transformer so that an existing low-voltage power source within the voltage ranges listed may power the RTU and charge the included battery.

» The **V274 External 12 Vdc option** deletes both the off-module power transformer and the off-module battery so that an external 12 Vdc power source, with battery backup, may be used to power the RTU. A solar-recharged battery is an example of such a power source.

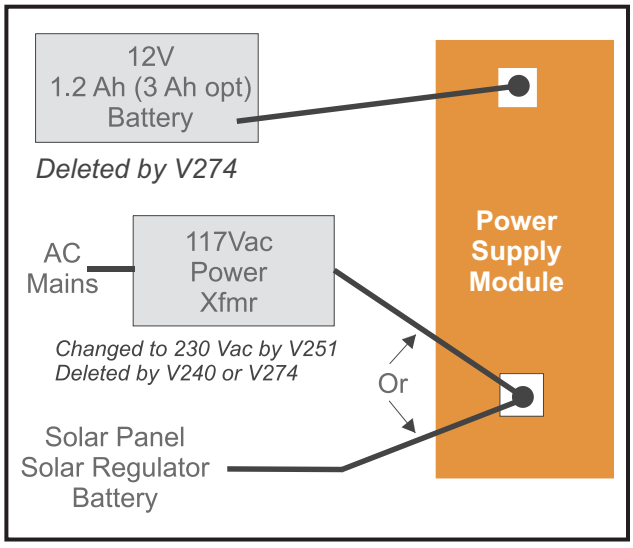



**Figure 2.** MOSCAD-L Power System

» The **V328 3 Ah Battery option** replaces the standard 1.2 Ah battery with a larger 3 Ah battery for longer operation when commercial power fails.

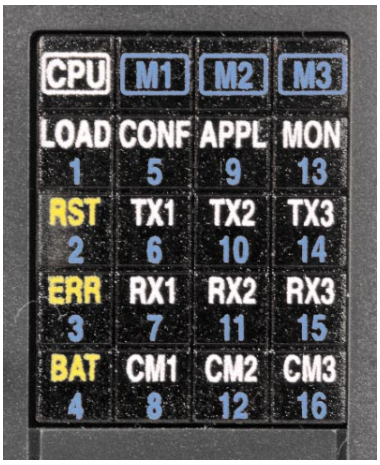
## CPU Module

The MOSCAD-L CPU module contains all of the product's intelligence. It has a Motorola 68LC302 16/32-bit CMOS processor, RAM and Flash memory, plus the interfaces to the I/O and communication aspects of the RTU; time functions are supported by a software clock in the operating system. The CPU module plugs into the module rack immediately adjacent to the power supply module. The CPU module may be programmed by ladder-logic, using the MOSCAD-L Programming ToolBox, to provide it with the capabilities expected of a PLC. Compiled functions written in "C" may be downloaded into the CPU module.

Each CPU module contains three data ports with different capabilities.

| Connection Type | Port 1 | Port 2 | Port 3 * |
|---|---|---|---|
| Local computer | Yes | Yes | Yes |
| RTU-to-RTU | Yes | Yes | Yes |
| User port | Yes | Yes | Yes |
| External modem | No | No | Yes |
| Ext. Dial modem | No | No | Yes |
| Protocol analyzer | No | Yes | No |
| GPS receiver | No | Yes | No |
| 3rd party protocol | Yes | No | Yes |
| X.25 | Yes | No | Yes |
| ** When using an RS-232 board in Port 3* | | | |

**Table 1**. Communication Capabilities of CPU Ports




» Port 1 provides either RS-485 (2-wire multidrop) or async RS-232 (data but no RTS, CTS, DTR, etc.) communications to the Programming ToolBox or sync RS-232 communications to CPU modules in other MOSCAD or MOSCAD-L RTUs.

» Port 2 provides async RS-232 communications and may be configured as either DTE or DCE for data connectivity under the control of the loaded application or configured as a system port for local ToolBox use.

» Port 3 is normally the communication port and contains a plug-in communication interface appropriate to the medium used. The port may also be provided with a full RS-232 plug-in when required.

Table 1 shows the types of communications available via each of the ports on the CPU module.

The CPU module includes 20 LEDs that provide information regarding the operation of the CPU and I/O modules. The LEDs indicate the availability of a configuration and application in Flash memory, communication status via the ports, state of I/O module connections, etc.

## I/O Modules

A variety of I/O modules are available to collect data from and send commands to other physical devices located at the site. The paragraphs that follow discuss the capabilities of the modules; the screw terminal connections on the modules are listed in Table 2.

### 6AI Module

The 6 Analog Input (AI) module provides six 4-20 mA analog inputs. Each of the inputs, plus ground, are opto-switched into a precision A-to-D converter; ground is measured so short-term drift may be canceled. Simply put, there are 4000 steps over the total ±20 mA range with 40% (1600 steps) of the total range in active use (see also Figure 10 in the MOSCAD System Planner.) The 24 Vdc wetting voltage may be used to power the analog loops provided that isolation between the DI and AI circuits is not required. The module utilizes plug-in screw terminal wiring connectors as shown in Table 2.

| | 6AI Module | 16DI Module | 8DO Module | Mixed I/O Module |
|---|---|---|---|---|
| Term | Fctn | Fctn | Fctn | Fctn |
| 1 | AN1+ | DI-1 | K1-NO | AN1+ |
| 2 | AN1- | DI-2 | K1-NC | AN1- |
| 3 | AN2+ | DI-3 | K1-com | AN2+ |
| 4 | AN2- | DI-4 | K2-NO | AN2- |
| 5 | P.gnd | DI-5 | K2-NC | P.gnd |
| 6 | P.gnd | DI-6 | K2-com | DI-1 |
| 7 | AN3+ | DI-7 | K3-NO | DI-2 |
| 8 | AN3- | DI-8 | K3-NC | DI-3 |
| 9 | AN4+ | com1-8 | K3-com | DI-4 |
| 10 | AN4- | DI-9 | K4-NO | DI-5 |
| 11 | AN5+ | DI-10 | K4-NC | DI-6 |
| 12 | AN5- | DI-11 | K4-com | DI-7 |
| 13 | AN6+ | DI-12 | K5-NO | DI-8 |
| 14 | AN6- | DI-13 | K5-com | DI-com |
| 15 | P.gnd | DI-14 | K6-NO | K1-NO |
| 16 | P.gnd | DI-15 | K6-com | K1-com |
| 17 | NotUsed | DI-16 | K7-NO | K2-NO |
| 18 | NotUsed | com9-16 | K7-com | K2-com |
| 19 | NotUsed | +24 Vdc | K8-NO | +24 Vdc |
| 20 | NotUsed | -24 Vdc | K8-com | -24 Vdc |

**Table 2**: Module Connections

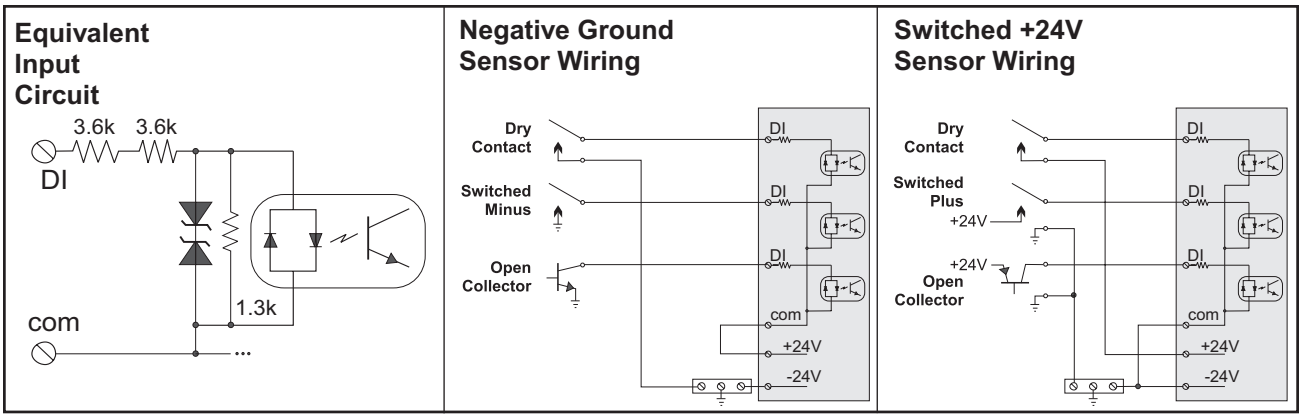



**Figure 3.** DI Wiring Suggestions

**16DI Modules**

The 16 Digital Input (DI) modules provides 16 wet digital inputs that may also be used as low-speed counters under application control. The V115 low-voltage module accepts voltage inputs in the 10-56 Vac/dc range and provides an isolated 24 Vdc wetting voltage so the open/closed state of dry-contact sensors may be determined—see Figure 3 for wiring suggestions. The V349 high-voltage module accepts nominal 117 Vac inputs. Each of the inputs are opto-isolated from the remaining circuitry on the module to provide the highest possible input surge immunity. The modules utilize plug-in screw terminal wiring connectors as shown in Table 2.

**8DO Modules**

The 8 Digital Output (DO) modules provides eight relay outputs. The V508 option provides a module with eight magnetically-latched relays whereas the V608 option provides a module with eight electrically-energized relays. Four relays provide Form A (normally open) contacts and four relays provide Form C (transfer) contacts. All relays are rated for 60 watt (dc) or 125 VA, not to exceed either 2 amps or 30 Vdc/250 Vac. Internal feedback from each relay is available so the application may determine the state of the relays. Both modules utilize plug-in screw terminals for connection of the associated wires (see Table 2.)

**Mixed I/O Module**

The Mixed Input/Output (I/O) modules provide a combination of features that satisfy the needs of many smaller sites. The modules provides eight wet digital inputs that may be used as low-speed counters under application control. An isolated 24 Vdc wetting voltage is provided so the open/closed state of dry-contact sensors may be determined—see Figure 3 for wiring suggestions. Each of the inputs are opto-isolated from the remaining circuitry on the modules to provide the highest possible input surge immunity.

There are two 4-20 mA analog inputs. Each of the inputs, plus ground, are opto-switched into a precision A-to-D converter; ground is measured so short-term drift may be canceled. Simply put, there are 4000 steps over the total ±20 mA range with 40% (1600 steps) of the total range in active use (see also Figure 10 in the MOSCAD System Planner.) The 24 Vdc wetting voltage may be used to power the analog loops provided that isolation between the DI and AI circuits is not required.

Two relay outputs, each with Form A contacts, are also provided. The V245 option provides a module with two magnetically-latched relays whereas the V436 option provides a module with two electrically-energized relays. Internal feedback from each relay is available so the application may determine the state of the relays. Both modules utilize plug-in screw terminals for connection of the associated wires.

# Communications

The littler and leaner philosophy behind MOSCAD-L applies to the communication device availability also. The 3 amp power supply output restricts radio selection to those with a low power consumption, namely the 5 watt VHF and 4 watt UHF HT-1000 or MTS2000, the 3 watt 800 MHz MTS-2000 radios, the 5 watt 900 MHz DARCOM Multiple Access radio, and the 900 MHz and 2.4 GHz Spread Spectrum radios. The non-Spread Spectrum radios plus their interface assemblies are packaged onto a small plate that is attached to the door of the MOSCAD-L enclosure; the Spread Spectrum radio is installed within the CPU module. Power for radios other than Spread Spectrum is obtained from the power supply module.

MOSCAD-L may be ordered with no internal radio. One such model provides an interface to an external radio – that radio must be provided with its own power source and protective enclosure because no space exists inside the MOSCAD-L enclosure for these components. Or, the less-radio MOSCAD-L may be ordered with one of several available wireline modems. The less-radio MOSCAD-L may also be connected by RS-485 cable to a second co-located MOSCAD or MOSCAD-L, and Store-&-Forward used to share the radio in that co-located RTU.

» MOSCAD-L may use the MDLC data protocol that is common to the MOSCAD RTU family or may use the Intrac 2000 protocol.
» MOSCAD-L may be used on the VHF splinter channels when an external radio that is type accepted for VHF splinter channel operation is provided separately.
» MOSCAD-L may be used with F1 emission (DFM) when connected to a suitable external radio. The system license must authorize the use of this emission.
» MOSCAD-L may be used with F3 emission (FSK, DPSK, or Intrac) when connected to a suitable internal or external radio. The system license must authorize the use of this emission. (See the separate discussion of New Rules below.)
» MOSCAD-L, with its internal DARCOM HR2 radio, may be used on the 900 MHz maS frequencies at 9600 (synchronous-only) data speed.
» MOSCAD-L is compatible with system designs that require operation through a designed-for-voice infrastructure which may itself introduce bandwidth reducing devices, such as notch filters in tone-controlled systems or PL/DPL filters in repeater systems.

MOSCAD-L has plug-in communication interface boards for MDLC to a radio (DFM, FSK, and DPSK—ToolBox selectable), for Intrac to a radio, for RS-232 to an external modem, and for the 1200 bps or 2400 bps internal modems. VHF and UHF models with the HT-1000 radio may not use DFM or FSK emis-

| | Output Power | Radio Interface | Rule Part | Emission Designator | Type Acceptance |
|---|---|---|---|---|---|
| Conv. HT1000 or MTS2000 136-174 MHz | 5 W (1-5) | MDLC * Intrac | 90 | 11K0F3E 16K0F3E | AZ489FT3768 |
| Conv. HT1000 or MTS2000 403-430, 450-470 MHz | 4 W (1-4) | MDLC * Intrac | 90 | 11K0F3E 16K0F3E | AZ489FT4780 or AZ489FT4781 |
| Trunked MTS2000 800 MHz | 3 W (1-3) | MDLC * Intrac | 90 | 14K0F3E 16K0F3E | AZ489FT5747 |
| DARCOM HR2 900 MHz MAS | 5 W | 9600 sync | 101 | 12K5F1D 12K5F2D 12K5F3E | ABZ9QCT6619 |
| | | * Default radio interface board | | | |

**Table 3**: Radio Availability & Licensing Data

sions but models with the MTS2000 radio may use FSK. The communication interface board plugs into a single socket in the MOSCAD-L CPU module; only one interface board of any type may be installed in the socket at a time. Refer to Table 3 for a listing of MOSCAD-L models, including interface board and the FCC Type Acceptance information for the included radio.

## Spread Spectrum Radio

MOSCAD-L may be ordered with an internal 900 MHz or 2.4 GHz Spread Spectrum radio. The radio plugs directly into the CPU module socket otherwise occupied by the communication interface board. All radio parameters, such as center frequency, data speed, etc., are set by the Programming ToolBox.

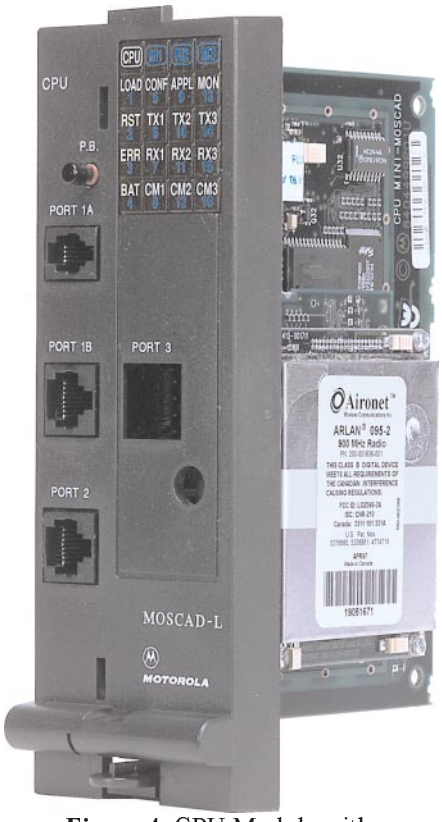



**Figure 4**. CPU Module with Spread Spectrum radio

No license is required to use Spread Spectrum radio. But there is no protection by law from interference by others, and no interference to others may be created. Data speeds are high (214 kbps @ 900 MHz, and 1000 kbps @ 2.4 GHz) but throughput may be affected by other local devices that also use Spread Spectrum technology (cordless phones, baby monitors, remote speaker systems, and more). Any decision to use Spread Spectrum radio must consider the uncontrollable delays that may be introduced by these devices. That decision must also consider the terrain because communication at these frequencies is definitely line-of-sight.

Two Spread Spectrum technologies have been defined. The radio used with MOSCAD-L utilizes the Direct Sequence Spread Spectrum (DSSS) approach instead of Frequency Hopping Spread Spectrum (FHSS) because DSSS permits direct peer-to-peer messaging via Store-&-Forward. Those sites that are Store-&-Forward nodes should utilize omnidirectional antennas whereas all other sites should use yagi directional antennas.

The rules in the U.S. and in Canada governing Spread Spectrum radio are similar and quite different from those normally encountered at VHF and UHF frequencies. The radio power output may not exceed one watt; the antenna gain may exceed 6 dB only if a corresponding reduction in output power also occurs; the antenna connectors must be unique and not commonly available (see Connector Note below). Motorola has identified the antennas that comply with these requirement; **substitute no other antenna**. The Rules use *dBi* in antenna gain definitions instead of the more familiar dBd; where dBi = dBd + 2.14, so please make the proper adjustments when predicting communication range, etc. The Aironet™ Spread Spectrum radios used in MOSCAD-L and the antennas identified comply with all these requirements; see Table 4 for details. No antennas are included with the MOSCAD-L models. Note that other countries may have different requirements so please consult the factory when use outside Canada or the U.S. is planned. Note also

| Model | Band | Power Output | Maximum Ant.Gain | |
|---|---|---|---|---|
| | | | MultiPoint | Pt-to-Pt |
| F6803 | 900 MHz | 450 mW | 9.5 dBi | 16.5 dBi |
| F6804 | 2.4 GHz | 100 mW | 16.0 dBi | 36.0 dBi |
| F6805 | 2.4 GHz | 50 mW | 19.0 dBi | n/a |

**Table 4:** Spread Spectrum Models

that systems in Canada that operate in the 2.4–2.45 GHz range and are in any part installed outdoors do require a license.

***Connector Note:*** Motorola has obtained a waiver from the U.S. FCC and from Industry Canada that permits professionally-installed MOSCAD-L to utilize standard Type N connectors instead of the non-standard connectors normally required. The Spread Spectrum models include a Type N connector on the enclosure. The antenna type and gain limitations have not been waived so choose antennas from established vendors that satisfy those limitations.

## New Rules

In the U.S., the FCC adopted new rules that affects how MOSCAD is used on two-way radio channels. The main purpose of the new rules is to change the bandwidth of the radio channels from 25 kHz or 30 kHz to 12.5 kHz so as to provide more channels. A data efficiency requirement was also added for when the channels are used for data.

In a secondary ruling, the FCC then defined *data* as a signal that does not pass through the audio processing and filtering circuits of the radio, and clarified *audio* as being those signals that do pass through the audio processing and filtering circuits. The FSK, DPSK, and Intrac signals used with MOSCAD-L always pass through the audio processing and filtering circuits – they are therefore audio, require an F3 (audio) emission designator for the radio, and are exempt from the data efficiency standard; these signals may best be described as being *signalling* and not *data*. DFM, however, may legally be *data* and require the F1 emission designator **if** that signal bypasses the audio processing and filtering circuits within the radio. The internal VHF, UHF, and 800 MHz radios used with MOSCAD-L are incapable of DFM operation.

## Wireline Modems

MOSCAD-L, like MOSCAD, has several internal modem options that may be used when desired. The wireline modem assembly consists of two pieces: one piece is installed in the CPU communication board socket and the second piece, which contains the physical connections to the line, is installed on top of the module rack. *It is mechanically impossible to have both a two-way radio and the internal modem in a single MOSCAD-L RTU!* A listing of the internal wireline modems and their option ordering numbers appear in Table 5. All modems provide full-duplex operation and operate on a 2-wire basis unless noted. They obtain operating power from the power supply module and therefore continue to operate during ac mains failure.

| | Multi-drop | PSTN | Pt-Pt | Notes |
|---|---|---|---|---|
| V219 | X | | | 1.2 kbps half-duplex only |
| V226 | | X | | 0.6-2.4 kbps 2-wire full-duplex |
| V404 | | | X | 0.6-2.4 kbps 2- or 4-wire full-duplex |

**Table 5**: Wireline Modem Options

## The Splinters

In the U.S. the FCC has defined certain frequencies in the 154 MHz and 173 MHz bands for data operation—the *splinters*. The frequencies are few in number, have an FCC-imposed deviation restriction, yet are very commonly used; they were not changed in any way by the FCC action described in New Rules. **The internal VHF radios used with MOSCAD-L are not capable of opertion on splinter channels.**

In an attempt to insure that the transmitted emission stays within the assigned channel bandwidth, the FCC has stipulated that a DPSK-like emission must be used and that the Sum of the Highest Modulating Fre-

quency plus Deviation shall not exceed a stated maximum. For most splinter channels, that maximum is 2800 Hz but on two frequencies the maximum is 1700 Hz. MOSCAD, when using DPSK modulation, uses a 1200 Hz modulating tone; the legal allowable deviation on the “2800” channels is therefore 1.6 kHz whereas on the “1700” channels the legal deviation is an unusable 0.5 kHz. When used with the Intrac interface, the highest modulating tone is 1500 Hz so the legal allowable deviation is 1.3 kHz and 0.2 kHz respectively. FSK is theoretically usable but at an inadequate deviation (0.3 kHz); DFM may not be used because it is not an F2 emission. PL/DPL must never be used because that deviation (0.75 kHz) must be subtracted from the data deviation which worsens an already marginal situation.

Therefore MOSCAD-L, using an external radio, may use DPSK modulation at 1.6 kHz or Intrac at 1.3 KHz deviation as the only legal emissions available for “2800” splinter frequency use; never use the “1700” frequencies and never use PL/DPL on a splinter frequency. Refer to the FCC rules or other applicable regulations to understand additional constraints on maximum Effective Radiated Power, antenna height, and antenna directivity.

### Repeaters, Fade margin, and Channel Loading

These topics are thoroughly discussed in the MOSCAD System Planner and those discussions apply also to MOSCAD-L. The reader is encouraged to examine the material on these topics in that document.

## Installation

The MOSCAD-L RTU is supplied in a fiberglass-reinforced lexan enclosure that is designed to the NEMA–4X standard. The physical dimensions (in millimeters and inches) of the MOSCAD-L RTU are summarized in Figure 5; a padlock ring is an integral part of the enclosure. Five “drill-outs” are present on the bottom of the enclosure for cable egress.

Two methods of attaching the enclosure to a pole or flat surface are provided. Four threaded inserts are present in the four corners on the rear of the enclosure for the connection of mounting brackets—see Figure 6. They may be positioned either vertically or horizontally, according to space available on site. Each bracket has a 0.4" (1 cm) hole for the fastener (not provided) that holds the brackets to the mounting surface.

When connection to a pole or similar structure is required, the snap-on mounting plate may be the solution. This plate is first attached with wood, machine, or lag screws through embossed mounting holes to the


**Figure 5.** MOSCAD-L Physical Dimensions

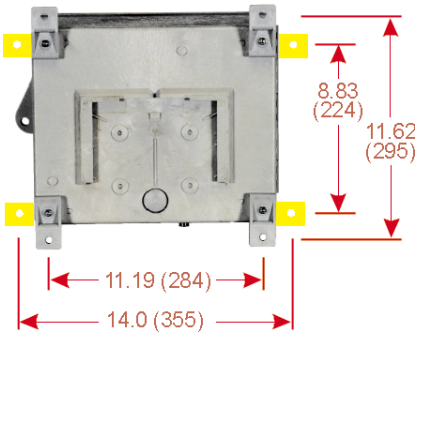



**Figure 6.** Enclosure with Corner Mounting Brackets

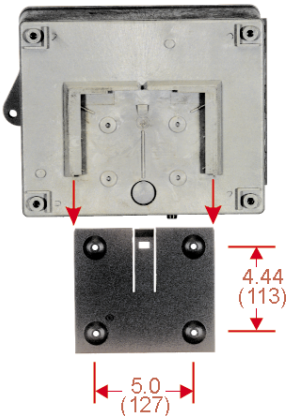



**Figure 7.** Enclosure with Wall-mount Bracket

mounting surface. The MOSCAD-L is then slid down onto the mounting plate—see Figure 7— until it snap-locks into position, an action that totally conceals the mounting screws.

Regardless of which mounting technique is selected, complete the installation by attaching rigid or flexible conduit to the bottom of the enclosure for the ac power plus Analog Input, Digital Input and Digital Output wiring. Please observe the standard practice of using different conduit by signal type: one conduit for ac power, a second conduit for Digital Inputs, and additional conduit for Analog Inputs, etc. This practice reduces the opportunity for voltage coupling (surges) among different wiring types.

Please read the warning in the Field Wiring sections that advises **not** to place the radio's antenna on the MOSCAD-L enclosure or in any location accessible by any human for any reason.

## Power Requirements

The MOSCAD-L RTU includes a power supply to power the radio and modules plus charge the internal battery. The MOSCAD-L unit operates on three internal DC voltages:

5 V for digital circuits

12 V for relays, drivers and LED display

24 V for wetting external sensors.

Solar powered operation is possible at remotely located MOSCAD-L RTU. This is a great convenience when commercial power is not available at a particular site. Before selecting the solar panel, the exact current consumption of the RTU must be established. The RTU with radio has three operating modes:

(1) Transmit mode with the maximum power consumption;

(2) Receive mode with moderate power consumption;

(3) Stand-by mode with the minimum power consumption.

The power consumption should be based on a worst-case average calculation. On quiet radio channels, the RTU normally is in a stand-by mode whereas it may, on busy channels, be in the receive mode most of the time. The duty cycle for the remainder of the time should be calculated from system activity estimations. For example, and using the system calculations in Chapter 5 of the MOSCAD System Planner, each RTU is interrogated once every 33.3 minutes thereby transmitting 2.32 sec/hr (1.286*60/33.3) and initiates one COS transmission every 20 minutes thereby transmitting an additional 2.38 sec/hr (0.793*60/20), for a total transmit time of 4.70 sec/hr. The RTU hears all other activity which uses 2341 sec/hr (39.1*60-4.7). The RTU will be in the standby state for the remaining 1254 sec/hr (3600-2341-4.7). The total current consumption is the sum of each individual time element plus the current consumption of the modules—see Table 6 and Appendix A.

| | |
|---|---|
| Transmit time current drain | 0.002 A (1.4*4.7/3600) |
| Receive time current drain | 0.046 A (0.07*2341/3600) |
| Standby time current drain | 0.024 A (0.07 * 1254/3600) |
| CPU + PS current drain | 0.25 A |
| 3 Mixed I/O current drain | 0.210 A (0.070*3) |
| TOTAL | 0.532 A |

**Table 6**: Sample Solar Power Calculation

A suitable solar panel, voltage regulator, and larger batteries—from BOSS in Scottsdale, AZ, Sun Wize Energy Systems in Orland Park, IL, or equivalent—must be provided.

## Field Wiring

The digital inputs on the 16DI and Mixed I/O module are *wet*—require a current through the on-module opto-isolators. MOSCAD-L provides a 24 Vdc voltage to wet sensors with dry contact outputs (connected to no voltage including ground). Other sensors that provide either switched ground or switched +24 Vdc may be

connected; see Figure 3 for typical sensor connections to the digital inputs. The 24 Vdc voltage source is isolated from ground so that either terminal may be connected to ground. This source is common to all I/O modules so be sure that one module doesn't ground the positive terminal while another module grounds the negative terminal!

The connectors on the MOSCAD-L modules are sized to accept up to a 14 ga. wire. This does not mean that every wire should be 14 gauge! Installers are urged to adopt a wiring plan that separates the wiring by function: keep the small signal digital input (DI) and analog input (AI) wires in one bundle; keep the large signal digital output (DO), etc. wires in a different bundle. Keep AC power wires in an even different bundle. Use small gauge wires for the small signal inputs/outputs because this physical difference is helpful when keeping the power wires away from the signal wires. Route these wire bundles separately, in different pieces of conduit. The intention is to prevent noise and transients on the AC power wires, or on the DO wires, from cross-coupling into the DI and AI wires. Physical separation is an excellent start.

Consider the addition of surge suppressers on the AC lines. The power supply and the modules have an excellent surge rejection capability. Nevertheless, if the surges can be eliminated outside the enclosure, then the opportunity to create harm will never occur and the equipment will surely operate better. It's simply anticipating trouble and eliminating it before it can occur.

Grounding! It's a topic that everyone understands the importance of, yet—too often—is not properly addressed. A good connection to a good earth ground is mandatory. The surge protective devices all shunt the surge energy to ground, away from the equipment. If the ground connection is poor or missing, then the surge protective devices cannot function and the opportunity for damage persists. Anticipate the problem and take corrective actions in advance.

Don't put the antenna on the MOSCAD-L enclosure. The plastic material does not provide the required ground plane so the radiated energy will be severely degraded. Even worse, the excess energy will spray in and around the modules and the service technician. Unwanted equipment performance has been documented and traced to these large RF energy fields enough times to warrant a blanket warning: put antennas on a pole, up in the air where antennas are meant to go. Do use only the Spread Spectrum antennas identified by Motorola with Spread Spectrum radios. The rules in Canada and the U.S. require unique and non-standard antenna connectors; the identified antennas comply with this requirement. Further, the rules place the legal obligation to insure compliance solely onto the installer – so avoid legal problems by observing this warning.

Another word about antennas. Use directional antennas whenever possible. Directional antennas focus the radio energy toward the receiving site thereby providing more energy (signal) to the receiving site. This translates directly to better fade margins, reduced opportunity for interference from off-axis radio equipment, and better signal throughput. Use omni-directional antennas only at those sites that must communicate with many other widely separated sites.

Make the installation *look* good: clean, shiny connections; wiring planned and organized; enclosures mechanically secured to a wall; etc. These all increase the probability that the installation will indeed be a good one!

# Ordering Guide

The information provided herein summarizes the ordering process and offers some helpful material regarding the selection of models, options, and accessories for the MOSCAD-L RTU. It is important to have a thorough understanding of the intended application, of the connectivity requirements to on-site sensors, and of the communication medium that will be used as the choices to be made depend upon that knowledge. The models, options, and accessories being ordered must appear on the order form in a very specific manner. The order input system will check each entry on the order against an established set of compatibilities; problems will be identified which will delay order acceptance until resolved.

## Choose the Model

MOSCAD-L RTU models are structured according to the communication device included within the model. Table 7 lists the models currently available; the basic model includes a power supply module, a CPU module, and expansion slots for three I/O modules. Refer to the RTU description section for a listing of other items included within each model and to the Communications section for a discussion of the capabilities of the communication devices. Models must appear on the order write-up as an item and may never be included within other items. The quantity ordered may be greater than one provided that each RTU has identical option types and quantities—see Table 9. A single frequency, or frequency pair when operation through a repeater is intended, must be listed on the order for all VHF, UHF, and 800 MHz models; Radio Service Software (RSS) may be used to change the frequency after shipment when needed. The model with no radio may have an internal wireline communication option added—see Table 5.

| | |
|---|---|
| F6801 | No radio or wireline communications |
| F6803 | 900 MHz Spread Spectrum |
| F6804 | 2.4 GHz Spread Spectrum |
| F6805 | 2.4 GHz Spread Spectrum (50 mW - Europe) |
| F6809 | MDLC interface to external radio |
| F6843 | 136-174 MHz MTS-2000 5 watt |
| F6853 | 136-174 MHz HT-1000 5 watt (DPSK only) |
| F6844 | 403-470 MHz MTS-2000 4 watt |
| F6854 | 403-470 MHz HT-1000 4 watt (DPSK only) |
| F6855 | 800 MHz MTS-2000 3 watt trunked |
| F6856 | 900 MHz DARCOM 5 watt (9600 sync only) |

**Table 8:** MOSCAD-L Models

## Choose the Options

Options are ordering conveniences that may Add capability, Delete capability, or Enhance some existing capability. Options must be ordered as sub-items to a model item; option quantities may be greater than one provided they are also multiples of the model's quantity—see the example in Table 8.

The available I/O modules are summarized in Table 7. Select one or more I/O modules according to the needs of the application and as supported by the associated on-site sensors. Each module occupies one I/O slot; be sure not to exceed the three slot maximum.

| | |
|---|---|
| V115 | 16 Digital Input module (10-56 Vdc) |
| V349 | 16 Digital Input module (117 Vac) |
| V278 | 6 Analog Input (4-20 ma) module |
| V508 | 8 Digital Output (ML) module |
| V608 | 8 Digital Output (EE) module |
| V245 | Mixed I/O module 8DI, 2AI (4-20), 2DO (ML) |
| V436 | Mixed I/O module 8DI, 2AI (4-20), 2DO (EE) |

**Table 7**: Summary of I/O Options

Communication interface options are also available which may be ordered when the product and communication design permits. Refer to Table 5 for a listing of which modem communication interfaces are available.

## Write the Order

The equipment being ordered may all be placed on one large order or spread across multiple smaller orders. A large single order provides the factory with the best visibility to the total system requirement; the multiple small orders facilitate the identification, by site, of boxed equipment for warehousing, staging, and transportation purposes.

All items with radios must have the transmit and receive frequency(ies) listed properly on the order except for items with a trunked radio. The factory uses the frequency information to insure that the proper radio

is included in the shipment. The radio is programmed on-site to the specific frequency or trunked system parameters by using Motorola RSS software (not included).

| Item | Qty | Model | Description | Comments |
|---|---|---|---|---|
| An incorrect writeup | | | | |
| 1 | 3 | F6843 | RTU VHF 5W | Three RTUs being ordered |
| 1a | 3 | V056 | Wall mount bracket | OK: 3 is a multiple of 3 |
| 1b | 5 | V436 | Mixed I/O EE | Wrong: 5 is NOT a multiple of 3 |
| 1c | 1 | FLN6457 | RS232 cable | Wrong: an accessory may not be a sub-item |
| The writeup corrected | | | | |
| 1 | 2 | F6843 | RTU VHF 5W | The first two RTUs |
| 1a | 2 | V056 | Wall mount bracket | OK |
| 1b | 4 | V436 | Mixed I/O EE | OK |
| 2 | 1 | F6843 | RTU VHF 5W | Added: the third RTU |
| 2a | 1 | V056 | Wall mount bracket | Added: OK |
| 2b | 1 | V436 | Mixed I/O EE | Added: OK |
| 3 | 1 | FLN6457 | RS232 cable | Added: the cable accessory |

**Table 9:** Sample Order Writeup

# Appendix

## **Appendix A:** MOSCAD-L RTU Current Consumption Worksheet**.**

This current consumption worksheet will help the system designer calculate the current drain from the primary power source. For example, the designer would use the @12 Vdc information if calculating the current drain from a solar panel/regulator that has a 12 Vdc output. Or the designer would use the @ 24V information to calculate the power drain (in watts) from the internal power transformer or from an external 24 Vdc power source

| Description | Input current in mA @ 12 Vdc | | Input current in mA @ 24 V | | Input current in mA @ 48 V | |
|---|---|---|---|---|---|---|
| | Receive | Transmit | Receive | Transmit | Receive | Transmit |
| *Communications:* 5 W VHF Conv. | 70 | 1400 | 60 | 1020 | 25 | 460 |
| 4W UHF Conv. | 70 | 1200 | 60 | 840 | 25 | 400 |
| 3W 800 Trunk | 75 | 1250 | 64 | 880 | 26 | 420 |
| 5W 900 DARCOM | 70 | 1600 | 60 | 1200 | 25 | 545 |
| 900 MHz SpreadSpectrum | 110 | 410 | 95 | 310 | 55 | 150 |
| 2.4 GHz SpreadSpectrum | 110 | 260 | 95 | 210 | 55 | 95 |
| Wireline Modem | 7 | 7 | 6 | 6 | 3 | 3 |
| *Modules:* CPU + Pwr Supply | 250 | | 200 | | 150 | |
| 6AI | 25 | | 19 | | 9 | |
| 16DI | 8 per input | | 5 per input | | 2.5 per input | |
| 8DO ML | 2 | | 1 | | 1 | |
| 8DO EE | 1 + 17 per relay | | 1 + 13 per relay | | 1 + 6 per relay | |
| Mixed I/O ML | 36 + 8 per input | | 24 + 6 per input | | 11 + 3 per input | |
| Mixed I/O EE | 36 + 8 per input + 17 per relay | | 24 + 6 per input + 13 per relay | | 11 + 3 per input + 5 per relay | |
| RS232 Multiplexer | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

# **Appendix B:** MOSCAD-L Specifications

## General

| | |
|---|---|
| Physical | Fiberglass-reinforced lexan enclosure, designed to NEMA-4X requirements (3 I/O modules); 14.63" x 11" x 8.75" (37 x 28 x 22 cm) |
| Environment | -30°C to +60°C; 90-95% RH @ +50°C |
| Expansion | 3 plug-in I/O modules into internal module rack; no rack expansion |
| Indications | 20 diagnostic LEDs on CPU module. manually switched among CPU and 3 I/O modules to display I/O status, etc. |

## CPU Module

| | |
|---|---|
| Processor | Motorola 68LC302 (16/32 bit) CMOS; 16.6 MHz clock, ±100 ppm |
| Memory | 1280 kByte (1024 kByte Flash, 256 kByte RAM) |
| Application Size | Not to exceed 256 kByte |
| Gate Array | I/O bus support<br>Watch-dog timer function<br>Remote symbolic debugging support<br>Early DC loss warning in case of AC failure for "clean" program and data recovery<br>Plug-in communication board support<br>Diagnostic LEDs, pushbutton, and flash memory programming voltage support |
| Port 1 | RS-485 serial data port (software controlled): 2.4-57.6 kbps 2-wire, *or*<br>RS-232D serial data port: 0.6-57.6 kbps |
| Port 2 | RS-232D: 0.3-57.6 kbps with full DTE/DCE support, transient protected |
| Port 3 | Radio (half-duplex, synchronous) via plug-in interface, *or*<br>Line communications according to plug-in interface and connection box, or<br>RS-232D serial (half-/full-duplex, synchronous or asynchronous); 0.6-57.6 kbps |
| Diagnostics | LEDs: power OK, AC failure, communication and application diagnostics, LEDs test |
| Alarms & Controls | Pushbutton control of LED status |
| Protection | Per IEC 801-2: air discharge = 8 kV, contact discharge = 4 kV<br>Per IEC 801-3: radiation immunity = 10 V/m<br>Per IEC 801-4: fast transient = 0.5 kV |
| Radiated Emission | Per CENELEC EN55022, class B |

## 16DI Module

| | |
|---|---|
| Inputs | Sixteen (16) inputs, 56 Vdc maximum |
| Input Frequency | Without interrupt upon COS: 5 Hz maximum<br>With interrupt upon COS: 50 Hz maximum |
| Input Signal | On: $V_{in} > 9$ V or $I_{in} > 1.0$ mA<br>Off: $V_{in} < 3$ V or $I_{in} < 0.3$ mA |
| Filtering | Software control of hardware filtering: 2-38 msec. Longer filtering within the application. |
| Interrupt upon COS | Event time-tag resolution = 5 msec. |
| Isolation | Per IEC 255-5: between user connection and logic = 2.5 kV; insulation resistance = 100 Mohm @ 500 V; insulation impulse = 5 kV |

**16DI 110 Vac Module**

| | |
|---|---|
| Inputs | Sixteen (16) inputs, 150 Vac maximum |
| Input Frequency | Without interrupt upon COS: 5 Hz maximum<br>With interrupt upon COS: 50 Hz maximum |
| Input Signal | On: $V_{in} > 60$ V or $I_{in} > 1.0$ mA<br>Off: $V_{in} < 30$ V or $I_{in} < 0.3$ mA |
| Filtering | Software control of hardware filtering: 2-38 msec. Longer filtering within the application. |
| Interrupt upon COS | Event time-tag resolution = 5 msec. |
| Isolation | Per IEC 255-5: between user connection and logic = 2.5 kV; insulation resistance = 100 Mohm @ 500 V; insulation impulse = 5 kV |
| Protection | Per ANSI/IEEE C37.90.1-1989: oscillatory wave = 2.5 kV; fast transient = 4 kV<br>Per IEC 801-2: air discharge = 8 kV, 4 kV contact<br>Per IEC 801-3: radiation immunity = 10 V/m<br>Per IEC 801-4: fast transient = 500 V |

**6AI Module**

| | |
|---|---|
| Analog Inputs | 6: 4-20 ma |
| Input Resistance | 226 ohm |
| Resolution | 12 bit (11 bit + sign) |
| Overall Accuracy | ±0.2% of full scale @ +25°C |
| Linearity | ±1 LSB |
| Filtering | Averaging: 1 or 2 or 4 or 8 samples |
| Temp. Stability | ±100 ppm/°V |
| Calibration | Automatic: software control of hardware calibration |
| Isolation | Per IEC 255-5: between user connections and logic = 2.5 kV; insulation resistance = 100 Mohm @ 500 V |
| Protection | Per ANSI/IEEE C37.90.1-1989: oscillatory wave = 2.5 kV; fast transient = 4 kV |

**Mixed I/O Modules**

| | |
|---|---|
| DIGITAL INPUTS | 8: specifications same as 16DI |
| DIGITAL OUTPUTS | 2 EE or ML SPST relays; specifications same as 8DO |
| ANALOG INPUTS | 2: 4-20 ma; specifications same as 6AI |
| Temp. Stability | ±100 ppm/°C |
| GENERAL Diagnostics | LEDs on CPU module: 8 DI status, 2 DO status, 2 AI underflow, 2 AI overflow |

**8DO Module**

| | |
|---|---|
| Outputs | Eight (8) relays, electrically energized or magnetically-latched |
| Relay Contacts | 4 SPST (Form A), 4 SPDT (Form C) |
| Contact Rating | Per UL: 0.6 amp @ 110 Vdc or 125 Vac; 2 amp @ 30 Vdc |
| Isolation | Per IEC 255-5: Between contacts = 600 V, between user connections and logic = 1.2 kV; insulation resistance = 100 Mohm @ 500 V; insulation impulse = 1 kV |
| Protection | Per ANSI/IEEE C37.90.1-1989: oscillatory wave = 2.5 kV; fast transient = 1.5kV<br>Per IEC 801-3: radiation immunity = 10 V/m<br>Per IEC 801-4: fast transient = 500 V |
| Diagnostics | LEDs on CPU module: 8 output status |

**Line Modem Board**

| | |
|---|---|
| Data Rates | Per CCITT V.21/Bell 103: 300 bps<br>Per CCITT V.22: 0.6 or 1.2 kbps<br>Per Bell 212A: 1.2 kbps<br>Per CCITT V.22*bis*: 2.4 kbps |
| Send Level | -21 to -6 dBm user selectable; DTMF dial-up: 0 dBm max. (with Line Interface Assembly) |
| Handshake Signals | Generation: answer tone, guard tone, S1 pattern<br>Detection: call progress, carrier, answer tone, unscrambled mark, S1 pattern, receive level & quality |
| Special Features | Scrambling & descrambling, adaptive line equalization |

**Line Interface Assembly**

| **DIAL-UP** | |
|---|---|
| Type | 2-wire, full-duplex |
| Isolation | Per IEC 255-5: between user connections and logic = 2 kV; insulation resistance = 500 Mohm @ 500 V |

**Power Supply**

| | |
|---|---|
| Input Voltage | 117 Vac or 230 Vac (nominal) with line transformer *or*<br>20-28 Vac or 21-50 Vdc without line transformer |
| Output Voltage | 5.0 Vdc, 14.3 Vdc, and 24 Vdc @ +25°C; ±5% each |
| Output Current | 0.6A @ 5 Vdc, 2.0A @ 14.3 Vdc, 0.25A @ 24Vdc |
| Load Disconnect | 10.5 ± 0.6 Vdc battery voltage (following input voltage failure) |
| Load Reconnect | Immediate (following input voltage restoration) |
| Safety | Per UL/CSA 1950 |
| Radiated Emission | Per FCC Part 15, Class A |
| Protection | Per ANSI/IEEE C37.90.1-1989: oscillatory wave = 2.5 kV |

## **Appendix C:** Radio Parameters

Use the Radio Service software to set the radio parameters according to the information provided below.

**HT1000 Conventional**

| | |
|---|---|
| RF Power | 4 or 5 W (var. to 1 W) |
| Switch Labels | All blank |
| Receive Only | Disabled |
| Direct/Talkaround | Disabled |
| T-O-T | 60 seconds |
| Phone Operation | None |
| Signalling | None |
| Squelch Type | Rx: CSQ |
| Smart PTT | Disabled |
| Auto Scan | Disabled |
| Emphasis On | Tx and Rx |
| Tx Deviation | 2.4 kHz @ 12.5 kHz<br>3.0 kHz @ 25 kHz |
| Mute/Unmute | Standard |
| Channel Spacing | 12.5 or 25 kHz |
| Rx Mute Delay | 0 |
| Reverse Burst TOC | Disabled |

**MTS2000 VHF/UHF Conventional**

RSS V05.60.00 or later

| | |
|---|---|
| **RSS F4:F3:F2** | |
| Alert Tone | Disabled |
| Low Batt LED | Enabled |
| Block Pending CA/PC | Disabled |
| Out of Range | No Indicate |
| **RSS F4:F3:F2:F7** | |
| Silent Alarm | Disable |
| **RSS F4:F3:F2:F9** | |
| MOSCAD capable | Enable |
| Disc tone | Disable |
| High Speed Tx | Disable |
| Fixed Volume | Disable |
| **RSS F4:F6:F3** | |
| Rx Only | Disable |
| Direct TA | Enable |
| Frequencies | Per system design |
| **RSS F4:F6:F3:F9** | |
| Smart PTT | PDisable |
| TX Power | High |
| Busy LED | Enable |
| Unmute/Mute | Unmute/Mute |
| Rx Unmute Delay | 2-100e |
| Reverse Burst TOC | Enable |
| Tx/Rx Emphasis | Enable |
| Tx Deviation | 2.4 @ 12.5 kHz<br>3.0 @ 15 kHz |
| Chan As Type | International |

**MTS2000 VHF/UHF/800 Trunked**

RSS V05.66.00 or later

| **RSS F4:F3:F2** | |
|---|---|
| Alert Tone | Disable |
| Low Batt LED | Enable |
| Block Pending CA/PC | Disable |
| Out of Range | No Indicate |
| **RSS F4:F3:F2:F7** | |
| Silent Alarm | Disable |
| **RSS F4:F3:F2:F9** | |
| MOSCAD capable | Enable |
| Disc tone | Disable |
| High Speed Tx | Disable |
| Fixed Volume | Disable |
| Mic AGC | Disable |
| **RSS F4:F4:F3** | |
| Sys Key | Enable |
| Sys Type | II/IIi |
| Sys ID | Per system design |
| Alias | Disable |
| Ind ID | Per system design |
| Connect Tone | Per system design |
| Cov. Type | Disable |
| Affiliation Type | On PTT |
| Dynamic Regrouping | Disable |
| **RSS F4:F4:F3:F6** | |
| Ctrl Channels/Ranges | Per system design |
| **RSS F4:F4:F3:F9** | |
| Tx Power | High |
| Chnl Bandwidth | 12.5 or 25 kHz |
| ISW Retry Timer | Disable |
| Status Alarm | Disable |
| *continued in next column...* | |

| **RSS F4:F4:F4** | |
|---|---|
| Protocol Type | II |
| System ID | Per system design |
| Type | II/IIi |
| Announcement Group | None |
| Individual ID | Per system design |
| Fail Soft Type | Disable |
| Rx FailSoft Freq | Per system design |
| Tx FailSoft Freq | Per system design |
| Time Out Timer | 60 sec |
| Private Call | Disable |
| Call Alert | Disable |
| Phone Interconnect | Disable |
| Status | Disable |
| Message | Disable |
| Scan List | None |
| **RSS F4:F4:F4:F7** | |
| Talk Group | Per system design |
| **RSS F4:F4:F4:F8** | |
| Protocol Type | II |
| Emergency Call | Disable |
| Emergency Alarm | Disable |
| Retry Counter | 1 |
| Tactical | Disable |
| Revert PTT | Disable |
| Revert Announce. Gp | None |
| Revert Talk Group | 001 |
| **RSS F4:F4:F4:F9** | |
| Conversation Type | Message |
| Talk Permit Tone | Disable |

# MOSCAD-L Glossary

| | |
|---|---|
| AI | Analog Input. A voltage or current, representing a physical value, generated by a sensor at a remote site. |
| Async | Serial data communications format that is not synchronized to a common clock signal. Characterized by start and stop bits and sometimes a parity bit in addition to the seven or eight data bits. |
| Baud | Unit of signaling speed. The speed in baud is the number of discrete conditions or events per second. If each event represents only one bit condition, baud rate equals bps. When each event represents more than one bit (e.g. dibit), baud rate is less than bps. |
| Bit | Binary Digit. Contraction of "binary digit", the smallest unit of information in binary systems; a one or zero condition. |
| Bps | Bits per second. Unit of data transmission rate. |
| Byte | A binary element string functioning as a unit, usually shorter than computer "word". Eight-bit bytes are the most common. Also called a character. |
| Contention | An alarm reporting method, in which the remote station alarms are reported "as soon as they occur", not just upon interrogation from the control center (see Interrogation). |
| COS | Change of State. Last reported change, sent from a remote station to the control center. |
| CPU | Central Processing Unit. Portion of the computer that directs the sequence of operations and initiates the proper commands to the computer for execution. |
| DFM | See Direct FM |
| DI | Digital Input. |
| Direct FM | A baseband (unmodulated) transmission method of MOSCAD-L data via a radio set having such capability ("F1" emission). |
| DO | Digital Output. A dry contact relay output available from the RTU. |
| DPL | Digital Private Line. A slow speed digital code that modulates the transmitter along with the desired data system information. The DPL code is typically used to gain access to high powered repeater/base stations. See also PL. |
| DPSK | Differential phase shift keying. A frequency modulation technique in which the phase of a single frequency tone is changed among several states to represent the 1/0 status of the data. A form of "F2" emission. |
| Dry Contact | A switch or relay contact that is not connected to any voltage or to earth, that is devoid of any other circuit. |

| | |
|---|---|
| F1 Emission | An FCC definition that applies to frequency modulated transmitters wherein the data source directly modulates the radio frequency. |
| F2 Emission | An FCC definition that applies to frequency modulated transmitters wherein the data source modulates a tone subcarrier with the subcarrier then modulating the radio frequency. |
| Fade margin | Additional signal level included in radio system designs to insure adequate signal strength when a communication path degrades due to normal propagation factors. |
| Flash Memory | A non-volatile and reprogrammable memory technology utilized in MOSCAD-L. |
| FM | Frequency Modulation. Angle modulation in which the instantaneous frequency of a sine-wave carrier is caused to depart from the carrier frequency by an amount proportional to the instantaneous value of the modulated wave. |
| FSK | Frequency Shift Keying. A frequency modulation technique in which one frequency represents a mark and a second frequency represents a space (“F2” emission). |
| Full Duplex | Simultaneous, two way, independent transmission in both directions over a data link. |
| Half Duplex | Transmission in either direction, but not simultaneously.. |
| Interrogation | Polling method in which the control center requests update information from its subordinate RTUs. The process may be initiated automatically or manually. |
| INTRAC | One of the Motorola SCADA equipment families. The protocol used by all Intrac 2000 equipment. |
| ISO | International Organization for Standardization. |
| kb | 1000 bits. |
| kB | kilo Byte, 1024 bits. |
| kbps | 1024 bits per second. |
| MB | Megabyte, 1,048,576 bytes. |
| MDLC | Motorola Data Link Control (protocol). Motorola’s seven layer communication protocol designed according to the OSI reference model. |
| MOSCAD | One of the Motorola SCADA equipment families as described in the MOSCAD System Planner. |
| NC | Normally Closed (Contact). A contact, the current carrying members of which are in contact when the operating unit is in normal position. |
| NEMA | National Electrical manufacturers Association. |

| | |
|---|---|
| NO | Normally Open (Contact). A contact, the current carrying members of which are not in contact when the operating unit is in normal position. |
| OSI | Open System Interconnection. The theoretical reference model of ISO intended for the design of open systems. |
| PLC | Programmable Logic Controller. An on-site processor that may be programmed to satisfy some specific requirement utilizing data obtained from on-site sensors. |
| PL | Private Line. A sub-audible precise tone that modulates the transmitter along with the desired data information. PL is normally used to gain access to high powered repeater/base stations. See also DPL. |
| PSTN | The Public Switched Telephone Network. The normal voice telephone service available through the world. |
| PTP | Point-to-Point. A radio system concept wherein two sites on a radio channel communicate only between themselves and with no other site. Typically employed when the two sites exchange large amounts of information. |
| Rackmount | The physical arrangement of MOSCAD to directly mount onto a 19" open or closed equipment rack. The lack of a physical enclosure permits expansion beyond the basic input/output constraints. Not available with MOSCAD-L. |
| RAM | Random Access Memory. A storage device in which the access time is effectively independent of the location of the data. |
| RTU | Remote Terminal Unit. The generic industry name for a remote alarm and control unit. |
| SCADA | Supervisory Control and Data Acquisition. The utility industry name for monitoring and control operation. |
| SPST | Single Pole Single Throw. Type of two contact relay in which the switched contact connects to (make) or disconnects from (break) a common contact. |
| Store-&-Forward | A capability of the MDLC protocol wherein data is received, validated, and stored until the communication medium becomes available wherein it is then forwarded to the next site. Communication infrastructures may be thus created in linear or star arrangements utilizing a single or a mix of different media types. |
| ToolBox | A collection of software tasks and tools that permit the MOSCAD-L RTU to be assigned a site ID, modules configuration, application program created and downloaded into the RTU, and more. |
| Trunking | A communications technique that permits a large number of radio users to efficiently share a limited number of channels. |
| UHF | Ultra High Frequency. Radio frequency range between 300 MHz and 3000 MHz. |
| VHF | Very High Frequency. Radio frequency range between 30 MHz and 300 MHz. |

| | |
|---|---|
| Wet | Adding a voltage to an otherwise dry contact so that the digital input module may detect a voltage change. |
| Wireline | The use of 600 ohm balanced wire link as a transmission path for telemetry data instead of radio link. |

This page intentionally blank

# INDEX