

## Downloading and Uploading Programs

### Why do I get a pop-up that says: “EEPROM locked or missing when I try to download a program”?

This only occurs under the following conditions:

The EEPROM is locked or missing in older Molex styled motors with external EEPROMS.

You are attempting a download to a “Plus” version firmware motor that is in a faulted condition. While faulted, the newer Plus version firmware will not allow a program to run. When SMI attempts a download, it first sends a blank test program that it tries to run. If the program does not run, then SMI assumes the EEPROM is either locked or missing. SMI2 does not pop up this message because it knows how to test for it ahead of time.

### Why will SMI2 not let me download to a SmartMotor that is moving or running a program?

Due to safety concerns, the new SMI2 software forces you to turn off the SmartMotor holding current or stop a running program prior to download to prevent possible unexpected motion. Example: Let’s suppose you have a program that places the SmartMotor in Velocity mode or Torque Mode and then you try to download without first tuning off the motor. During Travel, it will crash into the end stop while downloading. For safe operation we want to ensure the SmartMotor is in the OFF condition.

### When I start a download, the motor stops everything it was doing. Why?

When SMI starts a download of a new program, it issues the END command to stop prior code from running. This is to prevent processor memory pointer errors while the EEPROM header portion is being re-written. It is also for safety reasons.

### Is there a way to prevent someone from uploading a program?

Yes. You can protect your program from being seen or copied by sending LOCKP to the motor via serial port. The LOCKP command is a means of locking the program. It does not prevent a user from downloading a new program, but it does prevent them from seeing the program you have downloaded.

## I/O Handling

### Since the I/O is non-isolated 5 VTTL, are there any options for 24 VDC I/O?

Yes. There are a few options: Animatics provides cables with built in 5 V to 24 V isolated logic circuits right in the connector hood. This allows the user to have a choice of either 4 Inputs and 3

Outputs or 5 Inputs and 2 Outputs at 24 VDC. They can be set as sinking or sourcing. The partial Part numbers are CBLIO43 or CBLIO52 and can be purchased in lengths from 3 to 10 meters.

The DINIO7 is a DINrail mount breakout board that also provides a means of isolation using Industry Standard Opto-22, Gordos, or Grahill I/O modules such as ODC, IDC, OAC and IAC series. The DINIO7 also allows interconnection to other motors and their I/O via a built-in back plane.

### Are there any Expanded I/O options?

Yes. Each Motor has the ability to control expanded I/O via the AniLink™ protocol or RS-485. There are several Digital and Analog expansion options that allow up to a maximum of 64 channels of expanded I/O. In each case, Ports E and F are used to communicate with the AniLink Products.

Also available is the DIN-RS485 I/O card. Each card is a Din-rail mount 16 channel card with 8 24 VDC sourcing inputs and 8 24 VDC sourcing outputs. All I/O are optically isolated. Up to 200 DIN RS-485 cards can be on a single RS-485 bus controlled by SmartMotors. The outputs are short circuit protected.

### Are the I/O pins sourcing or sinking? (PNP or NPN?)

A straight answer is neither. They are actually CMOS compatible totem-pole outputs with the ability to be read as inputs. What this means is that when any given I/O pin (Port A through G) is set as an output (via UAO through UGO commands), and then is set to logic 1 or 0 (via UA-1 or UA-0 for example), the CMOS totem pole MOSFETs either hard drive the output pin to 5 VDC or 0 VDC. As a result, they are not open-collector outputs.

They BOTH source AND sink. However: when set as inputs via UAI through UGI commands, nothing is connected to the I/O pin at the connector; the input will appear as a logic level 1 (5 VDC). This is because ALL I/O pins have an internal 5 kOhm pull-up resistor tied to them.

### What type of electrical protection/isolation does each I/O pin have?

Each I/O pin has a 100 Ohm series current-limit resistor tied to a 5.6 VDC over-voltage limiting zener diode. The user ties into the 100 Ohm resistor directly. The connection between the 100 Ohm resistor and zener diode ties in directly to the CPU pin. This is why the motors are limited to 5 VTTL I/O logic levels only. Animatics does, however, provide 24 VDC I/O adapters and adapter cables for converting the 5 VDC I/O to optically isolated 24 VDC logic for connection to PLCs and other equipment. Please visit the Animatics website and search under Cables and Accessories.

## Power Supplies

### Which is better, Linear or Switcher Supplies?

Linear supplies are better suited for inductive loads. SmartMotors are inductive loads. Linear supplies can handle high current surges typically caused by starting and stopping of servo motors.

However, linear supplies have what is known as voltage droop. This is characteristic of voltage dropping down with an increase in load. Typically, unregulated toroidal transformer supplies will drop 4 to 7% and E-Core types (the big square transformers) are >10%. Switchers have no voltage droop until they reach maximum load. Then they just drop completely to zero volts. However, since they maintain a tight control over voltage up to the trip point, they can typically aid greatly in reaching maximum speed and acceleration of a given servo. However, the switching supply must be sized for the maximum expected peak current draw of the motor system. A linear supply only needs to be sized for continuous load. Linear supplies have a large capacitance to supply much higher current surges when needed, so this is more of an application specific question.

### What concerns are there with maximizing voltage on the supply?

The higher the voltage, the faster the SmartMotor can move and the faster it can accelerate. This is a good thing. However, in conjunction with this, the higher the voltage, the closer you get to a peak voltage that can cause over-voltage breakdown of the controller. Also, the higher the voltage, the faster a rate of change of current can occur. It is a risk with any application to get faster response by moving towards a higher voltage.

Typically speaking, it is the dynamics of sudden changes that increases risk by a "x<sup>2</sup>" factor whereas the continuous load risk is only a direct ratio increase. This is because rate-of-change in current is proportional to acceleration which is the square of velocity, i.e. x<sup>2</sup>. For safety sake, a 42 VDC supply for a 48 VDC system gives good margin with little speed losses.

### How do I size Power Supplies?

The quick answer is "more is better".

First, be sure you have the correct SmartMotor for the job. Once that has been done, take the nominal power rating for that motor and you should size a LINEAR supply to provide about 10% more power to allow for longer sustained current loads. Any LINEAR supply will typically provide more than enough peak current. This is where sizing gets tricky with Switch-Mode Power supplies. "SWITCHERS" typically come with some rated voltage and current.

For example: 48 VDC at 6 Amps.

Well, that is just it...this can provide 48 VDC nailed to the wall all the way up to 6 Amps, but if any more current is applied, the power supply will drop out to zero VDC and typically reset. Any time you wish to use switchers, you need to take the peak

expected load of the motor and size the switcher's continuous rating for that contingency.

As a rule of thumb, any 23 Frame SmartMotor™ "can pull as much as 12 Amps instantaneous. Most 23 Frame SmartMotors will not pull more than about 9 Amps instantaneous. A 10 Amp switcher can supply any 23 Frame SmartMotor for MOST applications.

With a 34 Frame SmartMotor will require a 20 Amp continuous rating to be sure you will not get a tripped power supply. 34 Frame SmartMotors can pull as much as 40 Amps or more for a few milliseconds, so as originally stated: "Bigger is better," especially when it comes to switchers.

## Back EMF

### How do I protect against Back EMF?

Short Answer: Don't back-drive the SmartMotor.

Problem is, back-driving the SmartMotor isn't the only means to produce Back EMF. Read the FAQ on "What is Back EMF and where does it come from?"

The best means to protect against Back EMF are to use a shunt such as the active 48 VDC 100 Watt shunt supplied by Animatics. It drops a 100 watt load onto the bus any time bus voltage exceeds 49.5 VDC. It removes the load when Bus voltage goes back down below 46 VDC.

It will work with Switching or Linear supplies as long as no-load voltage does not stay above 48 VDC. Otherwise the shunt will be on all the time. Another method of protection is to use a mechanical break controlled by the Break commands in the motor. The SmartMotor can respond to a fault and send a signal to the break within 250µseconds to help hold the shaft from back driving. None of these ideas helps against hitting a hard stop. Please read the FAQ on Back EMF for more.

### What is Back EMF and where does it come from?

Back EMF is the voltage generated when a rotor is moving within the stator of any motor. It is literally the motor acting as a generator. There is a common rule that Back EMF or voltage generated is proportional to Velocity. This is true in a constant velocity condition only. Back EMF is actually proportional to the rate of change of magnetic flux (magnetic field strength) inside the stator windings of the motor. The faster the rate of change, the higher the voltage rises. In other words, RPM of the motor shaft does not have to be that high to have very high voltages created.

Here is an example:

Take any relay coil or solenoid valve coil in a 24 VDC system. When it is energized, the magnetic field pulls in the contactor or pilot valve. The magnetic flux reaches saturation and a DC electromagnet is then formed. When the power is removed from the coil, the magnetic flux rapidly collapses because there is no forward voltage to maintain it. Since the circuit is not electrically open, there is nothing to prevent the magnetic flux from collapsing

rapidly at a hyperbolic rate.

The result is something called “inductive-kick”. This kick or spike in voltage for a 24 VDC coil can reach very high voltages and currents on the order of 100 times that of the original applied voltage, i.e. 2400 VDC! This is why it is very common to place reverse polarity diodes across relay coils and solenoid valve coils. It protects the system from high voltage spikes. The same thing occurs when a SmartMotor hits a hard stop. Suddenly, the rate of change of magnetic flux in the stator windings skyrockets upward because the rotor stopped moving. This sudden change causes an excessive voltage and current spike in the controller and can damage components.

Now what can we do about it? Practically speaking, not much. We could design the drive stage to be able to take the hit of a fast hard stop. But the drive stage would be very large. The controller would have a lot more components in it and the practicality of it would be diminished. The SmartMotor would grow in size for the same torque output to 3 times larger. This is just not practical.

**I was told the SmartMotor failed due to over-voltage, but I never back drove it or ran it fast...**

#### **HARD STOP CRASHES:**

The best recommendation for preventing damage to the SmartMotor/controller in the case of hitting a hard stop is to place a limit switch near the hard stop that trips the motor off line just prior to hitting the stop. The best way to prevent it beyond that is to prevent the cause of hitting the hard stop in the first place.

If this is due to jogging the SmartMotor in Velocity mode and not letting the jog switch in time, then jog in position mode instead and use the “X” or “S” command to stop the SmartMotor when the jog switch is released. In any case, ***much care should be taken to be sure the SmartMotor is not intentionally or unintentionally allowed to hit a hard stop while under normal speeds and load conditions.***

## **Communications**

**I have a SmartMotor that will not communicate no matter what I try. What should I do?**

It is possible to unintentionally write and download a program that will lock up the CPU or prevent serial communications. If you power it up and there is one or more LED lit up, then try the following: Isolate the SmartMotor by itself such that you have a single motor power and communications cable between the SmartMotor and the PC. Connect the motor to the PC serial Port, but DO NOT power up the SmartMotor. In other words, have the power supply either disconnected or turned off. Then start up the SMI software and click on the TOOLS drop-down menu.

Under TOOLS, click on “Communications Lock-up Recovery” and a pop-up window will tell you to do what is described above. Then click NEXT. The Lock-up recovery utility will begin transmitting multiple “E” characters to the motor. It will tell you to power-up the SmartMotor at this point.

Then it will wait about 1 second and attempt to establish communications. If it does establish communications, it will tell you and then prompt to either clear the program or upload the program. At this point, it is advisable to clear the EEPROM so as to down-power reset the motor and reestablish communications normally. This way you will know if it was just a program issue or a hardware issue.

If you apply power and there are no LEDs lit up on the motor, then there is a major problem with it electrically. It will have to be sent back for repair.

**Occasionally I lose communications and don’t know why. What could be causing this?**

Here are some general things to consider:

Shielding and Grounding must be done properly to insure good signal integrity.

Long character strings should be avoided. the receive buffer is only 16 bytes long.

Never use the shield as the ground reference connection for RS-232 or RS-485.

Make sure there are no non-terminating strings being transmitted. If a string is not followed by a carriage return or space character, the SmartMotor will hang indefinitely while waiting on the terminating character. It is done this way to allow priority to the serial ports over any downloaded program execution.

**How far can I transmit on RS-232 or RS-485?**

“RS” in the RS-232 and RS-485 specification means “Recommended Standard.” Not every company or chip manufacturer actually meets the “RS.”

The IEEE specification states that RS-232 single-ended signal is SUPPOSED to be +/-12 VDC or a 24 VDC swing from logic zero to logic 1. The specification for RS-485 is +/-5 VDC Differential. By voltage levels, RS-232 will logically be able to transmit much further. By noise immunity, a differential signal should be able to reach its destination “cleaner”. But the reality is similar to the following analogy: a clean whisper can’t be heard a mile away, but a loud guttural voice can. So in reality, RS-232 can transmit further, but RS-485 transmits cleaner.

Also note that the higher the voltage level, the higher the induced noise must be to overcome the signal, so RS-232 isn’t so bad after all. As far as actual distances go, there are applications in the field running 250 feet on RS-232. RS-485 just can’t drive the cables well enough to go beyond 100 feet without experiencing loading problems. Also, RS-485 is a parallel bus. The more motors you add, the shorter the overall practical distance due to bus loading. RS-232 is serial. Therefore, one motor transmits directly to only one “receive” buffer. This means compounded bus loading does not occur. This is another reason RS-232 can actually transmit further.