



SM263 MOTOR CONTROLLER

Support Manual

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Introduction

The SM263 is a compact, general purpose DC motor controller. It is available in 12V and 24V versions, with a steady output of up to 80 Amps. It has a range of features to suit different situations that may be selected by the installer.

Standard features include:

- Low battery warning
- Dampened acceleration
- On-board Forward/Reverse/Brake control
- Stall & over-current protection
- Simple 2-wire control circuit manages speed, direction and On/Off
- Reduced speed in reverse
- Self-test & safety checks upon power up
- Supports Dynamic (resistive load) Braking

An optional backlit Liquid Crystal Display (SM267) can be fitted to give the operator information on battery condition, drive status and system integrity



Protection Features

Four levels of protection from stalled motor events. Should a full locked-rotor stall occur, a rapid beep will warn the operator that a brief power reduction down to 30% drive will occur if they persist. Additional safety software monitors the integrity of the power semiconductors when the throttle is at rest. The software which will automatically isolate the motors should any drive fault conditions be detected, making it a very safe controller to use.

When first activated, the throttle must be *at-rest in the Forward direction*, or warning beeps will sound and the controller is disabled until this is done. This safety feature guards against the possibility of a runaway vehicle if the throttle was rotated before battery power was first applied.

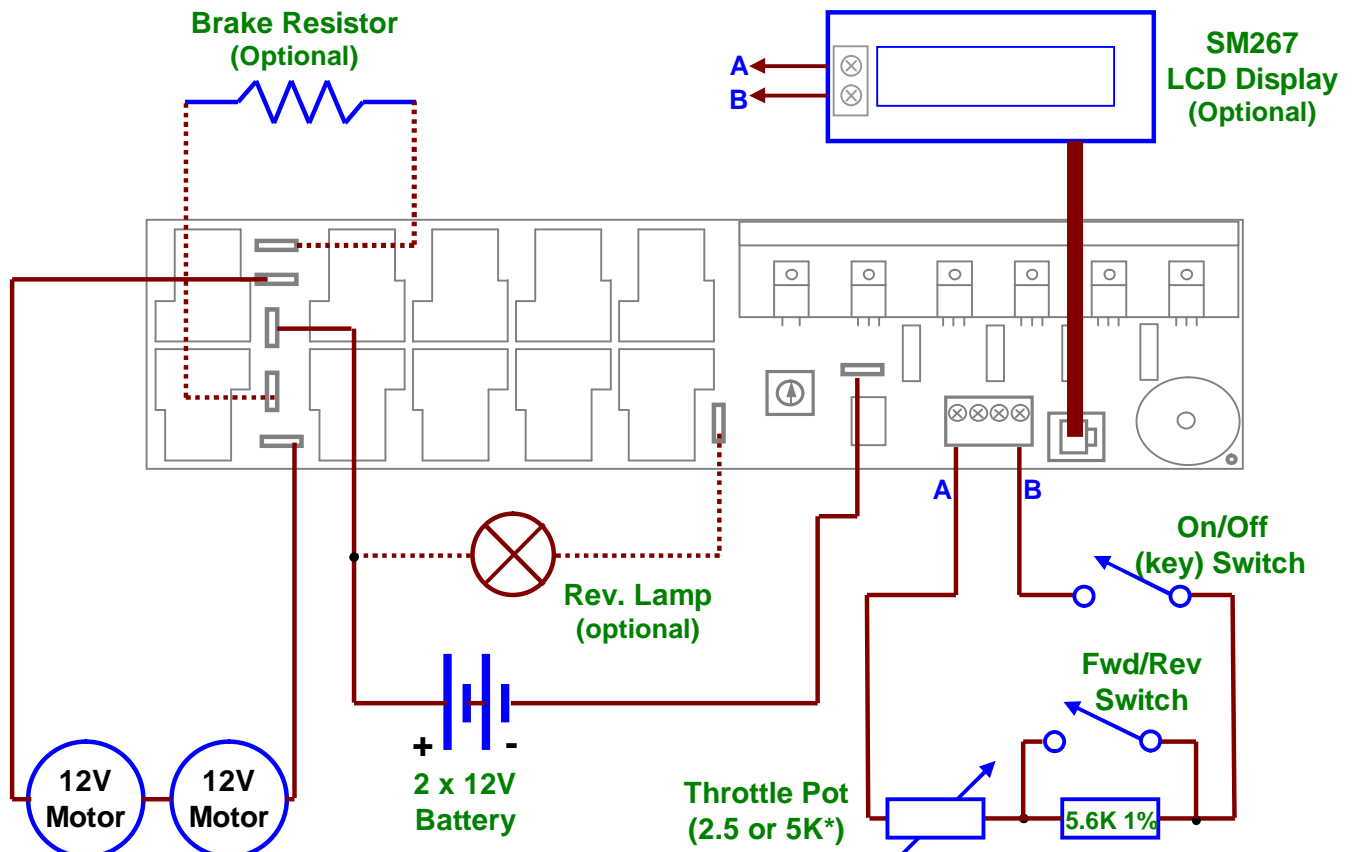
Direction Control

Motor rotation activity is monitored by the microprocessor to prevent the user going into hard reverse while still moving or rolling forwards. This protects both the user from experiencing sudden changes in acceleration and protects a gearbox and drive components from mechanical stress damage.

Simple Connections

The controller supports one or two 12V motors, or one 24V motor. Throttle Potentiometer, Key switch, Forward/Reverse switch all connect via a single wire loop circuit. The display connects via a common RJ12 (telephone style) patch cable.

SM263 MODULE – ELECTRICAL CONNECTIONS (24V system)



- A 5K linear pot may be used where mechanical backstops limit pot rotation to 150°
- Throttle connection points **A B** indicate wiring may connect via the Display, or direct to the controller.

Specifications:

Motor Type supported:

Supply Voltage:

Output current:

Dimensions:

Weight (controller)

Power connections:

Direction Control

Speed Control:

Current Sensing:

Throttle Control

D.C. Permanent Magnet

12 or 24VDC

80 Amps

288 x 70 x 34mm

124g

6.3mm vertical tab

Relay switched 'H' bridge

0-100% PWM via 5 MOSFETS

Hall Effect

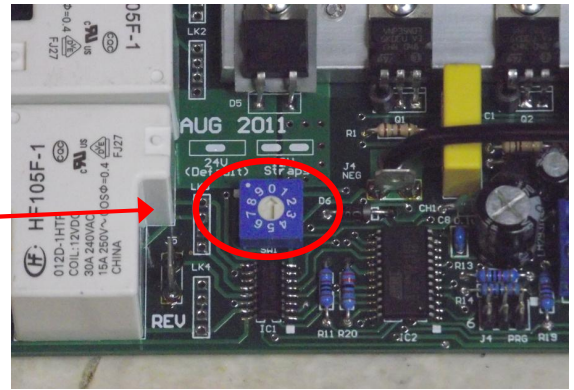
0 - 2,500 Ohms spread required

SETTING OPTIONS WITH THE SM263 CONTROLLER

The **SM263** controller has a range of options that may be turned **On** or **OFF** depending upon the circumstances of its use. These options may be set by rotating the 10-position **Option Switch** and using throttle controls to **Enable** or **Disable** these features.

Position '**0**' is the **Normal** position where the controller drives the motors. The switch should always be returned to this position. In all other positions the drive is shut off and motor relays are deactivated.

**OPTION
SELECTION
SWITCH**



Position	Description	Default Setting
0	Normal position	-
1	Reduce speed in reverse	Enabled
2	Use braking resistor	Enabled
3	Slow down rate of acceleration	Enabled
4	Display Current instead of Battery Meter	Disabled
5	Turn off relays after 4 minutes	Enabled
6	Signal fault if motor is missing or relays faulty	Enabled
7	Signal alarm if battery is low (<18V)	Enabled
8	Warning Beep if motor is > 60 Amps	Enabled
9	Show hour meter (on LCD Display)	-

To change a setting to **ENABLED**,

- Turn the **Option Switch** to position **1- 8** to select the appropriate option
- Set the Forward Reverse switch to **FORWARD**
- Rotate the throttle to **MAXIMUM** for 2 seconds.
- The unit will beep once and the selected option will be **ENABLED**

If a display has been fitted then it will indicate the option and its current status

To change a setting to **DISABLED**,

- Turn the **Option Switch** to position **1-8** to select the appropriate option
- Set the Forward Reverse switch to **REVERSE**
- Rotate the throttle to **MAXIMUM** for 2 seconds.

The unit will beep twice and the selected option will be **DISABLED**

Special note for vehicles without **REVERSE** switch

Some vehicles are not equipped with a reverse switch. Accordingly this would make it impossible to reach the **DISABLED** setting via the Reverse Throttle control. This may be overcome just by holding the throttle at maximum **FORWARD** for *more* than 2 seconds. At the 4 second mark, the **DISABLED** setting with its double-beep will be achieved.

The LCD Display Option

An LCD display (model **SM265** or **SM267** from **Alian Electronics**) may be plugged into a controller by way of a 6-way telephone style patch cable. This has no effect on the performance controller as it is used solely for viewing controller settings and alarms.



Direction switch set to Forward

The display is slightly backlit so that information may be viewed even under low light levels.

The **SM267** display also accepts throttle wiring to minimise the cabling requirements between the display location and the controller. (see [connection diagram on Page 2](#))

When the blue option switch is in its '**Normal position 0**' the display will show the **Battery Condition, Direction Status** and the amount of energy being delivered to the motor (**0 -100%**).

Where the Resistive Brake option has been fitted and enabled, returning the throttle to the zero position while in the **FORWARD** direction will show the **<BRAKE>** message indicating that the resistive brake has been engaged.

The battery indicator represents an approximation of battery voltage. It is expressed as a percentage between 16 and 27 Volts. (on a 24V system) For example, a battery voltage of 22V may be expressed as approximately 50% charged. The exact figure will vary somewhat as the intensity of the load applied to the controller also affects immediate battery voltage readings.

NOTES on Setting (1) - REDUCED SPEED IN REVERSE

When this option is **ENABLED**, speed in the reverse direction is limited to approximately **70%** of maximum speed. This is useful where it is appropriate for an operator to be moving slowly when reversing a ride-on vehicle in a confined area.

NOTES on Setting (2) - USE BRAKING RESISTOR

When this option is **ENABLED** the motors will be placed across the braking resistor whenever the throttle is returned to zero while in the Forward direction.

If this option has been enabled and the resistor is not present then at power-up the self test feature will detect this as a fault and report it with 4 beeps before shutting down.

NOTES on Setting (4) - SHOW CURRENT

When **ENABLED** this setting will replace the Battery Level Indicator (0-100%) with the present current consumption in Amps.

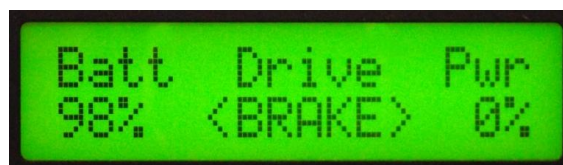
Note that this is an approximation only and displayed values may vary from actual readings by +/- 5%.

NOTES on Setting (5) - AUTO-SHUTDOWN AFTER 4 MINUTES

When this option is **ENABLED** all relays will be released 4 minutes after the last time the throttle control was used. This is simply a power saving feature for when the vehicle has not been used for some time. Whenever the throttle is used again, the relays will automatically re-engage.



Direction switch set to Reverse



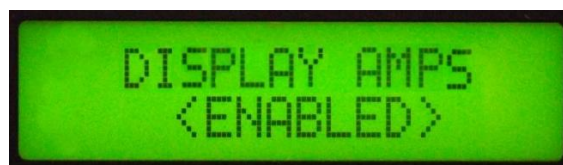
Display showing Brake Resistor engaged



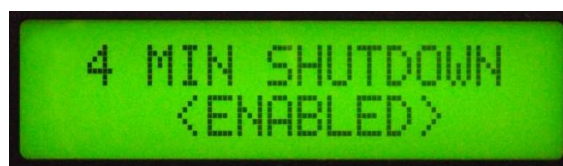
Setting up speed limiting in reverse



Setting up braking resistor option



Enabling Current Readings



Display showing Auto-shutdown timer

NOTES on Setting (6) - THE POWER-UP SELF-TEST

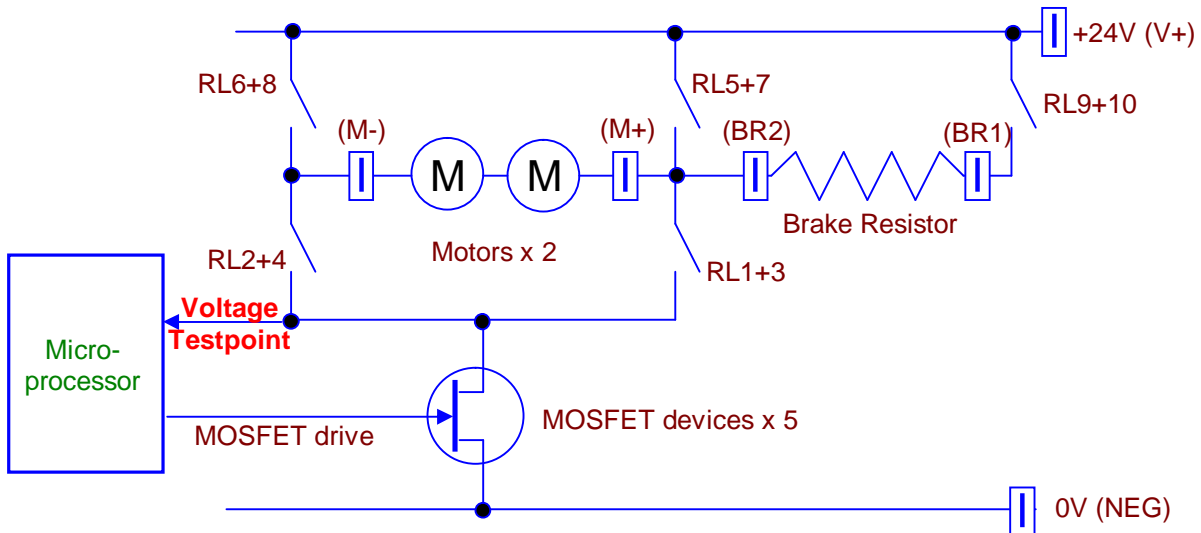
If this setting **ENABLED**, the controller will perform a full circuit diagnostic upon each power up. If this setting is **DISABLED** then these tests are bypassed. These tests are repeated when switching from Option Switch Setting 1 to 9 back to the normal '0' position.



Display showing Motor Checks feature

Simplified Schematic of Motor and Power connections:

(actual terminal designations are shown in brackets)



(Note that all relays are in pairs for greater current carrying capacity)

Depending upon the combinations of relay pairs that are active, the motors are either isolated, connected between 0V and +24V via the drive MOSFETS (in either polarity), or be connected across the Brake Resistor.

The Microprocessor monitors the point labelled as **Voltage Testpoint**. During the test sequence it operates various relays and looks for correct contact integrity over a series of four tests.

Test 1 – Check Relays 1 to 4

In this test it operates relays 5+7 and checks the Voltage Testpoint. If +24V is measured, then it means that either of relays 1,2,3,4 must be stuck in an 'operated' state. If this is the case, a fault message is sent to the screen, the controller will beep twice, then do nothing more.

Test 2 – Check Relays 5 to 10

In this test it operates relays 1+3 and checks the Voltage Testpoint. If +24V is measured, then it means that either of relays 5,6,7,8,9,10 must be stuck in an 'operated' state. If this is the case, a fault message is sent to the screen, the controller will beep 3 times, then do nothing more.

Test 3 – Check for Brake Resistor integrity (if fitted)

In this test it operates relays 1+3 and 9+10 and checks the Voltage Testpoint. If +24V is NOT measured, then it means that the brake resistor is missing. If this happens while the Brake Resistor setting (2) is **ENABLED** it means that there must be a resistor open-circuit fault. If this is the case, a fault message is sent to the screen, the controller will beep 4-times, then do nothing more. If the Resistive Braking feature is Disabled, (option setting 2) then this test is not performed.



Display showing brake resistor fault

Test 4 – Check for the presence of a Motor

In this test relays 1+3 and 6+8 are operated so that a +24V potential should be extended through the motors into the Voltage Testpoint. . If +24V is NOT measured, then it means that either or both of the motor connections are missing. If this is the case, a fault message is sent to the screen, the controller will beep 5-times, then do nothing more.



Display showing motor wiring fault

NOTES on Setting (7) - LOW VOLTAGE ALARM

If this setting is **ENABLED** and the battery has fallen below 19V (24V system) or 9.5V (12V system), then there will be a warning triple-beep every 25 seconds as a reminder that the battery is low. During this time the top line of the display will frequently display the '**LOW BATTERY ALARM**' message to the operator.



Slow-Flashing Low Battery Alert

NOTES on Setting (8) - STALL WARNING

If this setting is **ENABLED** and the cart exceeds approximately 70 amps, there is a non-invasive rapid beep each second to alert the operator that they are approaching a completely stalled condition. When the current falls below the 70A threshold, the beeps automatically stop.



Display showing Stall Warning feature

NOTES on Setting (9) - HOURMETER FUNCTION

When this position is selected, the display (if present) will show the number of hours, minutes and seconds that the controller has been driving a load in either Forward or Reverse. No activity is recorded when the vehicle is not in motion.



Display showing motor usage counter

NOTES ON INTERNAL PROTECTION FEATURES OF THE SM263.

The need for protection

With motor control there is a fine line between the amount of energy that can safely be delivered to a drive system versus the amount energy that the operator may *want* extract from the motors.

This usually results in a compromise, where we let the operator '*do their worst*' under a wide range of conditions, but if it appears that pursuing an action will fry the electronics or otherwise damage the vehicle, then of necessity, the operators wishes must be limited by controller programming. A classic example of this is a locked-wheel condition where the operator is attempting to jump a gutter with a personal electric vehicle and they pour large amounts of energy into the motors where the wheels simply cannot turn. Without protection, catastrophic failure could occur in a motor winding, motor bushes, melting of wiring, stripping a gear in the gearbox or destruction of the MOSFET devices that switch energy to the motors.

While the SM263 controller is notionally an 80 Amp unit, such a complete stall event could potentially draw almost twice that energy level from the battery. Unless there is immediate automatic intervention by the controller logic, some form of catastrophic mechanical or electrical failure to the vehicle would be likely.

Limitations of fuse & circuit breaker protection

Simple fuse or circuit breaker protection are of limited practical value in field conditions. The threshold of trip within a circuit breaker can vary with ambient temperature and battery state-of-charge. Such protection may be slow to react and usually does not self-reset, meaning a vehicle may be inconveniently stranded until some level of intervention by service staff is applied. This may necessitate a long 'push' to the car park and cause great inconvenience to the operator.

SM263 protection levels

There are **FOUR** separate strategies employed by the controller electronics to protect the integrity of the vehicle. While a knowledge of this is not essential to the operation of the controller, it can help service staff if the nature of these strategies are understood.

1. Motor Frequency Shift under heavy loads

Upon normal acceleration a series of pulses are directed to the DC motors. The ratio of on-to-off or *duty cycle* of these pulses determines the speed of the vehicle. Usually this frequency is set to 3.8 kHz. (3,800 pulses-per-second) It can be heard as a faint, high-pitched squeal when first accelerating from a stationary position. The SM263 has a feature whereby if the motor current is approx. **50 Amps** or higher, the drive frequency is automatically dropped to only 470 Hz. (470 pulses-per-second) When this happens, the operator may notice the shift in tone applied to the motors. This lower switching frequency will help to protect the MOSFET devices when driving heavy loads, but by only invoking it when necessary, reduces motor drive whine when the loads are light.

2. Automatic Stall Warning feature

This feature has no effect on the operation of the vehicle, except that it informs the operator when they are driving the vehicle or load quite hard. It is really present just to help curb operator behaviour. When the motor current rises above approximately **70 Amps** for two seconds or more, a '**double-beep**' can be heard at slow one-second intervals. These warning beeps automatically cease when current falls below this 70Amp threshold. It is sometimes difficult for the operator to discern how hard a load is being driven. This feature can serve as a reminder.

This warning feature can be turned on or off by selecting **Stall Warning ENABLED** or **DISABLED** within the controller using **Option Setting (8)**.

3. Automatic Stall Protection – Level 1

This is a brief, Self-resetting shutdown mode. If the current to the motors reaches **80 Amps** for more than **Half-a-second**, it is evident that the vehicle is being pushed to its limits. An automatic stall protection is invoked for **Two Seconds**. During this two seconds period the controller will rapidly beep and the motor drive is limited to **80%**. (This will limit peak current to a safer level.)

If a display module is fitted to the controller, the message: **<LIMIT>** will appear on the screen during this 2-second protective mode.

At the end of this 2-second protection mode, normal operator control is restored. However, if the operator persists with this high-stress activity, this protective mode down may be repeated.

It is possible that the operator may at first dislike this feature, but it is set internally to an extreme level, where damage to the vehicle in one form or another is a likely outcome if they continued to pursue this behaviour. By encouraging the operator to be conscious of high-current consumption situations battery usage time may be extended by up to 20%.

4. Automatic Stall Protection – Level 2

This is similar to **Level 1** protection, except the threshold is a higher **100Amps** and the half-second 'grace' period within Level 1 is not applied. If the vehicle current spikes higher than the **100Amps** at any time, even briefly, the same 2-second shutdown with rapid beep will be engaged and drive will be limited to 80% during this time.

This final level of protection is important as an extreme over-current event could cause some vehicle damage even within the brief half-second tolerance window permitted in **Level 1**.

SM263 Throttle Pot Resistance versus Motor Drive level

Throttle Position	Direction	Ohms	Drive %	Relays	Comments
MINIMUM THROTTLE	Fwd	2900	0%	1,3,6,8	(Relays 6,8,9,10 Brake Res option)
END OF FREE PLAY AREA	Fwd	2100	0%	1,3,6,8	(Relays 6,8,9,10 Brake Res option)
	Fwd	1890	20%	1,3,6,8	
	Fwd	1680	30%	1,3,6,8	
	Fwd	1470	40%	1,3,6,8	
	Fwd	1260	50%	1,3,6,8	
	Fwd	1050	60%	1,3,6,8	
	Fwd	840	70%	1,3,6,8	
	Fwd	630	80%	1,3,6,8	
	Fwd	420	90%	1,3,6,8	
	Fwd	210	100%	1,3,6,8	
MAXIMUM THROTTLE	Fwd	0	100%	1,3,6,8	
DEAD ZONE	N/A	3000	0%	none	All relays released
DEAD ZONE	N/A	5400	0%	none	All relays released
MINIMUM THROTTLE	Reverse	8460	0%	2,4,5,7	
END OF FREE PLAY AREA	Reverse	7500	0%	2,4,5,7	
	Reverse	7310	20%	2,4,5,7	
	Reverse	7120	30%	2,4,5,7	
	Reverse	6930	40%	2,4,5,7	
	Reverse	6740	50%	2,4,5,7	
	Reverse	6550	60%	2,4,5,7	
	Reverse	6360	70%	2,4,5,7	
	Reverse	6170	80%	2,4,5,7	
	Reverse	5980	90%	2,4,5,7	
	Reverse	5790	100%	2,4,5,7	
MAXIMUM THROTTLE	Reverse	5600	100%	2,4,5,7	
LOCK CONTROLLER	N/A	>11000	0%	none	Open cct. Throttle loop

When controller is initially powered, the throttle must be placed in the RED zone or no relays will activate and the controller will beep rapidly. (see **Protection Features** on Page 1)