

DM60-GM WHEELCHAIR CONTROLLER

INSTALLATION MANUAL

Reference Number - 24456

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1.0 INTRODUCTION

The DM60-GM wheelchair controller is a dual channel, high current switching controller designed to control the speed and direction of two twenty four Volt DC power wheelchair motors. It is designed to be used in conjunction with a separate remote with a built-in joystick control. The controller uses ultrasonic pulse width modulation (PWM) to efficiently control the power and voltage to the motors.

The DM60-GM features a microcomputer for flexibility and safety. Flexibility is achieved by making the controllers field programmable and performance parameters can be adjusted with a separate Programmer. Safety is enhanced because the microcomputer continuously monitors the joystick, internal voltages, output voltages and currents and internal circuits. An independent safety circuit enables the wheelchair user to test the battery isolate relay drive circuitry at turn on and continuously monitors the relays during operation.

All connectors are housed on the controller and comprise battery plug, left and right motor sockets, remote loom and programming sockets as shown in figure 2. The controller also incorporates the circuit breaker for the battery current and a fuseholder for the logic supply.

2.0 FEATURES

2.1 CONTROL AND SAFETY LOGIC

All control functions are performed by an 8 bit microcomputer with digital precision and reliability. Redundant checking by the microcomputer enhances safety by minimising the risk of undetected system faults.

The safety logic includes a battery isolate relay monitor that enables the user to verify normal relay operation at turn on. It also continuously monitors the relay contacts and shuts down the controller if a relay fault is detected. Verification of operation of the relay monitor, relay and relay drive circuitry is performed by the user at turn on and is described in section 8.0, "User Test Procedure".

2.2 POWER STAGES

The power stages use PWM to control the voltages to the motors. High current field effect transistors switch motor currents at an ultrasonic frequency in a full bridge configuration achieving efficiency and ruggedness. Fast current limiting circuitry protects the transistors against short circuits and stalled motors.

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2.3 LOAD COMPENSATION

Load compensation ensures exact motor control, compensating for variations in motor loading under different wheelchair driving conditions. Motor currents are continuously monitored and the output voltages adjusted to compensate for the voltage drop in the motors due to the current flowing through the motor resistance.

Load compensation ensures that the power to the motors suits the driving conditions, whether on thick pile carpets, polished floors, or driving across a slope.

2.4 PRECISE CONTROL ON SLOPES

Due to load compensation and an adaptive park brake delay, the DM60-GM controller minimises uncontrolled movement of a wheelchair when parking on a slope and ensures maximum user control.

2.5 USER CONTROLS

The DM60-GM is designed to be used in conjunction with user controls mounted in a separate remote unit that connects to the controller via the remote cable. The normal user controls are ON/OFF switch, inductive joystick and maximum speed pot'. The maximum speed can be set by a potentiometer in the remote and the BDI, ON and fault status indicated by an incandescent lamp or LED.

The specification of the joystick is given in appendix 2.

2.6 STATUS INDICATION

The lamp (located on the right side of the remote, in front of the joystick as shown in figure 1) indicates the controller status as follows :

1. Lamp on continuously All systems normal, controller ready.
2. Lamp flashing slowly (once per second) Battery state-of-charge is low. Recharge battery as soon as possible.
3. Lamp flashing quickly (twice per second) Wheelchair system (battery, motor, parking brake or controller) fault has been detected. Driving inhibited.

Note: The park brake output may be open circuited to inhibit the controller when charging the battery for instance. The on lamp will flash if the controller is turned on while charging.

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See "Safety and Fault checks", section 2.8.

2.7 CONNECTORS

A 5 pin Beau plug provides battery input; there are separate 4 pin (with fifth polarising pin) female Beau connectors for the motors and park brake outputs, a single 7 pin DIN programming socket and an AMP 14 pin CPC connector for the remote. These connectors are shown in figure 2 with pin outs in figure 3. The recommended wiring to the battery and motor connections and park brake is described in section 5, "Electrical Installation".

2.8 SAFETY and FAULT CHECKS

The microcomputer checks for the following conditions and may remove the drive to the motors, actuate the parking brake output(s) (stopping the wheelchair) and indicate a fault (by flashing the status lamp) if any of these conditions are detected:

Fault Code	Description
1.	Battery voltage too high (greater than 28V) OR joystick deflected (less than 50% of travel) when controller turned on.
2.	Park brake(s) fault.
3.	Battery voltage too low (less than 22V).
4.	A joystick signal (speed or direction) outside its normal

operating range.

5. Left and right motor voltages not consistent with joystick demand, controller fault.
6. Controller battery isolate relay fault
7. Controller memory fault.

The particular fault is indicated by encoded flashing of the lamp. The fault code (except code 1) is the number of flashes (where the number depends on the fault) of fast flashes followed by a long OFF period. This sequence repeats while the controller is left on. The number of flashes can be counted to determine the fault code.

Fault code 1 produces continual flashing with a short on and off period and may be caused by:

- . switching the controller on with joystick deflected less than 50% of maximum travel. (Controller will drive until joystick is returned to neutral for 2 seconds. Greater than 50% deflection enables test mode, see section 8.0).
- . attempting to drive the wheelchair with an overcharged battery. (The controller enables driving when the voltage drops below the maximum battery voltage).

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Electronic circuitry protects against the following failure, hazard, or overload conditions:

1. Battery connected with wrong polarity.
2. Microcomputer master clock, bus or software failure
3. Overheating under heavy loads such as occur when the wheelchair motors are stalled for an extended period.

Note: Stalling the motors for a long time may damage the motors, wiring or batteries.

2.9 PERFORMANCE CUSTOMISATION

The Dynamic Controls Programmer enables the user to customise the performance of the DM60-GM controller to his or her needs. Eight different parameters can be customised by plugging into a programming socket in the controller and setting the desired level using the controller's joystick. The parameter level is displayed by the Programmer's meter.

Programmer Mode	Function
1. Overall	Sets all of the following adjustable parameters to give an overall

response ranging from slow and very
damped to fast and very responsive.

2. Forward	Sets maximum forward speed.
3. Reverse	Sets maximum reverse speed.
4. Turn	Sets maximum turning rate.
5. Accel.	Sets forward and reverse acceleration.
6. Decel.	Sets forward and reverse deceleration.
7. Turnaccel.	Sets turning acceleration.
8. Turndecel.	Sets turning deceleration.

Refer to the Programmer operating manual for details.

3.0 HANDLING

The DM60-GM controller is a sophisticated electronic assembly and should be handled carefully.

1. Do not subject to unnecessary or excessive mechanical shocks.
2. Do not connect anything to the controller unless it is in accordance with an approved wiring diagram.
3. Do not make any wiring connections or modifications while the battery is connected.

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4. Do not subject to temperatures outside these ranges:
In Storage -35 to 60 Deg C.
While Operating -10 to 50 Deg C.

4.0 MOUNTING

The DM60-GM controller is designed to be mounted using M5 screws into the mounting bushes. The screw length should be chosen to screw into the blind threaded bushes to a maximum thread depth of 10mm. The orientation of the controller is not critical although the label is positioned for vertical mounting.

The controller case is air cooled and therefore air is to be allowed to freely pass over at least one side of the case.

5.0 ELECTRICAL INSTALLATION

Connections to the battery, motors and park brakes are

made via polarised connectors.

5.1 BATTERY SUPPLY

The DM60-GM controller is designed to be used with heavy duty deep cycle lead-acid batteries with a capacity rating greater than 20 amp-hours. Use of batteries with capacities less than this is not recommended.

5.2 BATTERY OVERLOAD PROTECTION

A resettable thermal circuit breaker is incorporated in the controller to protect the wheelchair's electrical system and the user.

5.3 BATTERY WIRE AND MOTOR WIRE RATINGS

The following MINIMUM wire rating should be used for the indicated wheelchair loom wire lengths:

Battery wires		Motor wires	
< 400mm	> 400mm	< 400mm	> 400mm
5 mm ²	6 mm ²	4 mm ²	5 mm ²

Add 0.5mm² for every 500mm longer than 400mm

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NOTE: These minimum wire sizes will ensure that power loss in the wiring is not excessive. Using a larger size wire will further improve efficiency.

5.4 MOTOR TYPE

Good load compensation requires that the level of compensation is matched to the wheelchair motors. Insufficient compensation will result in loss of performance and the wheelchair will exhibit the following symptoms:

1. Have some uncontrolled movement when parking on a slope.
2. Exhibit poor steering response on undulating surfaces.
3. Feel sluggish.

Matching low series resistance motors is especially important because of the motor's responsiveness to small changes in voltage and may result in unstable or jerky wheelchair operation if the load compensation is not matched to the motors.

Consult the factory to discuss your application.

5.5 PARK BRAKE CONNECTIONS

A parking brake output is provided on pin 13 of each motor connector. These pins are (for the TUV compliant DM60-GM controller) connected inside the controller to separate park brake drives which are separately monitored.

The park brake outputs are controlled by the microcomputer actuating (releasing) the park brakes when the motors are driven. The outputs can supply up to 1 Amp at 24 Volts for each outputs. They are current limited to protect against short circuits.

The wheelchair's park brakes are to be of the fail safe type:

engaged when electrically de-energised and released when energised.

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IMPORTANT:

If the wheelchair has manual park brake release mechanisms that mechanically disengage the park brakes overriding the electrical control, then to conform with TUV requirements the wheelchair is to have microswitches that allow the controller to detect the released state. The microswitches are to be open circuit when the park brakes are manually released (or disengaged) and closed circuit when the manual override is removed (and the park brakes can be controlled electrically). In this configuration, if the park brakes are manually overridden, the controller, if on, will flash the status indicating (on - off) lamp and not energise the motors. When the manual override is removed the park brakes are controlled by the wheelchair controller being released when the wheelchair is driven and engaged when the wheelchair has stopped. (The on - off lamp is lit continuously).

Each 24 Volt park brake coil is to be connected to a park brake output from the controller via a 4/5 pin Beau connector. A microswitch is to be connected in series with each park brake coil, see figure 1.

The microswitches are to be open circuit when the park brakes are manually overridden and closed circuit when the manual override is removed.

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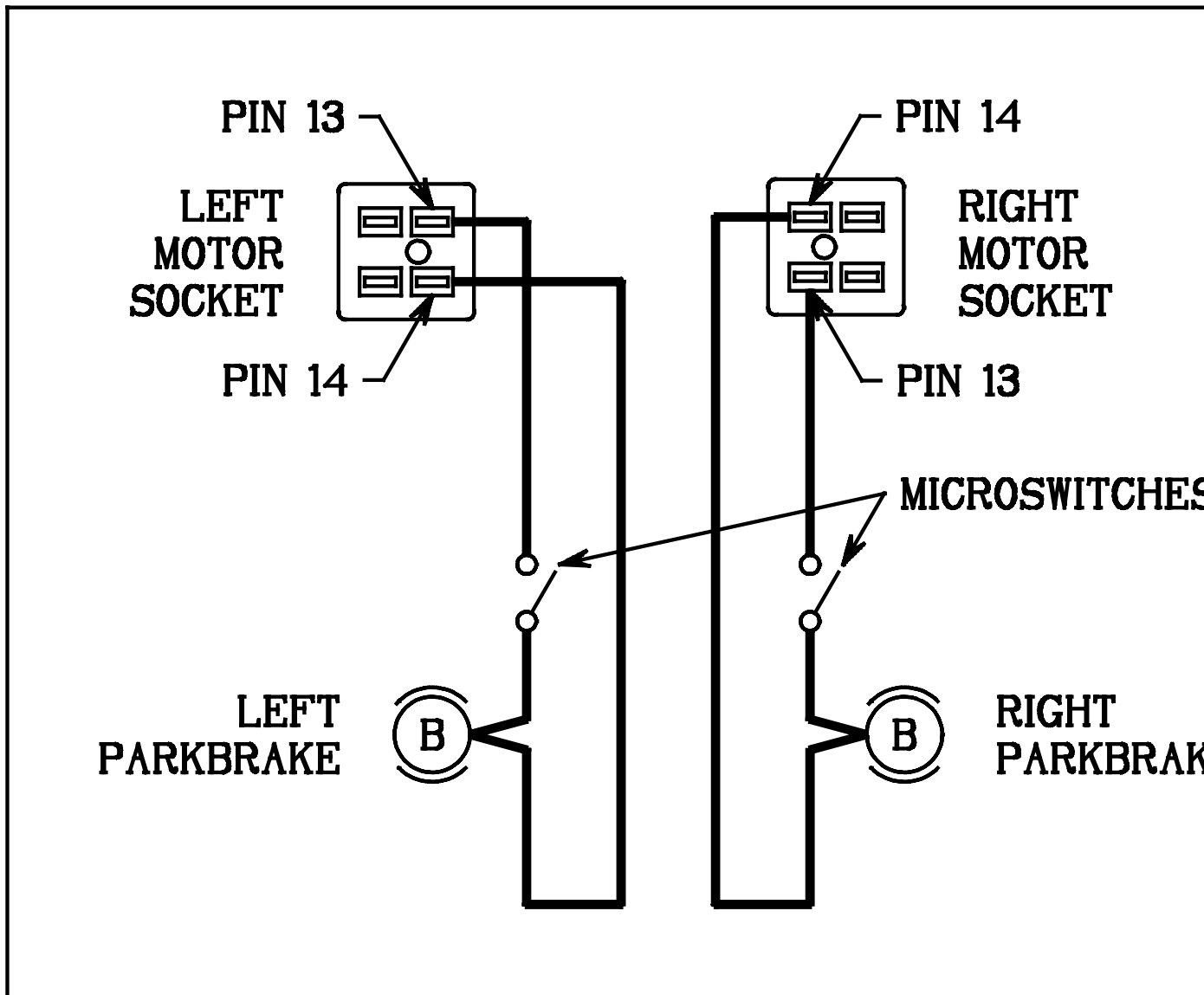


Figure 0. 24 VOLT PARK BRAKE COIL CONNECTION DIAGRAM

5.6 INHIBITING THE CONTROLLER WHILE CHARGING

The DM60-GM has only the inhibit input on the program socket and this is unsuitable for inhibiting the controller when a charger is plugged in. An alternative to using the controller's inhibit is to open circuit the logic supply when the charger is plugged in at the remote or a separate key plug. This could be done, for example, by connecting one pin of the charger socket to the battery supply and the other to the ON/OFF switch in the remote. When the key plug is installed these pins are shorted enabling the controller.

6.0 INSTALLATION TEST PROCEDURE

The object of this test is to ensure that there is no fault in the wheelchair wiring looms, controller, remote or batteries after installation.

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To prevent uncontrolled wheelchair movement it is recommended that the drive wheels of the wheelchair be supported off the ground before the following procedure is carried out:

Test Procedure:

1. Plug in the DM60-GM controller and switch on (by switching the ON/OFF switch in remote, ON).

and Check the on - off lamp is on and is not flashing that the wheelchair's wheels are not rotating.

2. Switch controller off at the remote.

3. Hold the joystick fully forwards and switch on.

Check that the wheels do not rotate and that the warning beeper inside the controller sounds. See section 8.0, "User Test Procedure".

Turn the controller off then on again.

4. Move joystick forward and check that both wheels start to turn and accelerate smoothly in the FORWARD direction.

5. Move joystick backward and check that both wheels start to turn and accelerate smoothly in the BACKWARD direction.

6. Move joystick to the right and check that the right wheel runs in the backwards direction and the left wheel in the forwards direction.

7. Move joystick to the left and check that the right wheel runs in the forwards direction and the left wheel in the backwards direction.

Upon the successful conclusion of these tests, lower the wheelchair to the ground and carry out the wheelchair test procedure below.

7.0 WHEELCHAIR TEST PROCEDURE

This suggested wheelchair test is designed to test for satisfactory performance of the controller, remote, motors and wheelchair wiring.

Before starting the tests, ensure that the wheelchair batteries are in a good state of charge.

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1. Turn maximum speed control knob in remote fully clockwise (if fitted).

2. Turn the controller on at the remote, then off and several times without touching the joystick.

Check that the parking brakes are NOT energised even momentarily. The park brakes will click when energised or de-energised.

Note: The relays inside the controller will click when the controller is turned on.

Leave controller switched on.

3. Move joystick slightly forward.

Check that the park brakes on both motors are energised and are heard to click. (The controller's relays will also click).

4. Drive wheelchair slowly (with small joystick deflections) in the forward, reverse, left and right directions.

Check for precise control.

5. Drive wheelchair at maximum speed (full joystick deflections) in the forward, reverse, left and right directions.

Check speeds feel correct for the wheelchair.

6. Drive the wheelchair at full reverse speed.

Check that initially the wheelchair does not deviate from a straight line in reverse by more than 20 % of the distance travelled.

Note 1: This characteristic depends on the channel balance in the controller and wheelchair motor matching. A wheelchair with well matched motors (better the 1% speed matching) must be used for this test to have any value.

Note 2: Rear wheel drive wheelchairs tend to have an unstable characteristic in reverse which, due to inertia, causes the wheelchair to tighten the turn when it starts to turn and eventually to drive in circles.

7. Drive with joystick in full forward (on the "flat" of the joystick's restrictor plate).

Check that the wheelchair can be steered to the left and to the right while still on the "flat".

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8. Turn the maximum speed control knob full anti-clockwise and repeat 5.

9. Turn the maximum speed control knob fully clockwise. Drive the wheelchair full speed forward and then move the joystick fully reverse.

Check that the wheelchair decelerates smoothly in a straight line before stopping and moving backwards.

10. Repeat test 9. but move the joystick from full speed reverse to forward.

Note: Deceleration in reverse is less than in forward.

11. Drive the wheelchair slowly forward and then switch the controller off.

Check that the wheelchair immediately stops.

12. Hold the joystick slightly forward (about 25% of available travel in the forward direction) and switch on.

Check that the wheelchair does not drive. Release the joystick for 2 - 3 seconds and then check that the wheelchair drives normally.

13. Drive the wheelchair up a ramp with 1 in 6 gradient and attempt to accelerate from a slow speed.

Check the wheelchair can climb at a normal speed.

14. Reverse down the ramp with a 1 in 6 gradient.

Check the wheelchair can be controlled and brakes as expected.

15. While driving the wheelchair slowly up the ramp, release the joystick.

Check that the wheelchair does not roll back excessively (for the type of wheelchair and

transmission arrangement) before the park brakes operate.

16. Continue driving up and down the ramp four times and check the controller's case temperature is not excessive (for the type of wheelchair and never exceeding 65 degrees C).

17. Switch the controller off.

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8.0 USER TEST PROCEDURE

IT IS RECOMMENDED THAT THE FOLLOWING PROCEDURE IS PERFORMED DAILY BY THE WHEELCHAIR USER PRIOR TO USING THE WHEELCHAIR (EQUIPPED WITH A DM60-GM CONTROLLER). THIS RECOMMENDATION IS TO BE INCORPORATED IN THE USER'S MANUAL.

1. When the controller is off, hold the joystick on the remote fully forward and then switch on.

2. The beeper inside the controller will sound if the battery isolate relays and relay driver circuitry operate normally. The absence of this sound signifies a potentially serious failure in the controller.

In the case of failure, switch the controller off and contact a wheelchair service agent.

3. Switch off.

4. The wheelchair is now ready for normal operation and can be switched on normally (without deflecting the joystick).

9.0 CARE AND MAINTENANCE

1. Do not leave the DM60-GM controller exposed to direct sunlight for long periods. This may overheat the case (which absorbs heat very well) and reduce the available motor currents and hence the ability of the wheelchair to climb obstacles or ramps.

2. Do not continue to use the remote if the rubber joystick gaiter has holes or cracks in it. Extraneous material (possibly from the gaiter itself) will very likely fall into the joystick mechanism resulting in rapid deterioration of the joystick. It will also

allow moisture into the joystick and remote.

3. Protect the controller and remote from liquid spillage. Should a liquid be spilt on to the controller or remote wipe off with an absorbent cloth as soon as possible.

10.0 TROUBLESHOOTING

These instructions are designed to assist in diagnosing a problem after the controller and remote has been installed on a wheelchair. If, after diagnosing the likely cause and following the suggested action, the problem persists then an authorised service person should be called.

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1. On lamp in the remote does not light when the controller is turned on at the remote.
 - 1.1 Possible connection problem. Check that the battery connector is correctly plugged into the controller and that the battery connections have not been reversed. Check the cleanliness of the battery connections, and if necessary, clean.
Recharge the batteries.
 - 1.2 Batteries very flat. Recharge the batteries.
 - 1.3 Lamp blown. Check that the wheelchair drives normally. Replace bulb.
2. On lamp in the remote flashes slowly (once per second).
 - 2.1 Batteries are nearly flat. Recharge the batteries.
3. Lamp flashes rapidly (twice per second).
 - 3.1 Check park brake manual overrides (one for each park brake) are removed if the wheelchair is equipped with them.
 - 3.2 Check that the battery charger is not plugged in.

- 3.3 Check that the motor connectors are plugged in.
- 3.4 If the fault has been removed switching the power off then on again will clear the fault indicating condition.
- 3.5 If the fault persists charge batteries.
- 3.6 If the fault still persists call the service agent.

4. The ON/OFF lamp is on, controller clicks when joystick deflected but the wheelchair does not move.

- 4.1 Check that both the drives from the motor are engaged.
- 4.2 Check that motor connectors are plugged in.

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5. The wheelchair lacks power.
batteries.

- 5.1 The batteries are nearly flat. Recharge the

- 5.2 The batteries are faulty. Have the batteries and charger checked.

up

- 5.3 The park brakes are dragging. Check for heat build in brakes after one minute driving, have brakes serviced if necessary.

6. The chair does not drive straight.

connections.

- 6.1 One motor is disconnected. Check motor

gearbox,
if

- 6.2 One motor and or gearbox is faulty. Check motor and consult service agent necessary.

- 6.3 Park brake dragging. See 5.3.

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11.0 APPENDIX 1: DM60-GM CONTROLLER TECHNICAL SPECIFICATION

Revision B
1990

September 25,

11.1 Specification

The DM60-GM conforms to the following specification over an ambient temperature range of -10 to 50 Degrees Celsius and relative humidity of 10 to 80 percent.

Abbreviations:

A - Ampere, V - Volts, C - Celsius, kHz - kilohertz,
max - maximum, min - minimum

11.2 Supply (Battery) Voltages

(a) Operating Voltage 24V
Nominal

(b) Maximum supply voltage (for safe

	controller operation)		
28V			
(c)	Absolute max. supply voltage (averaged over 10 mSec interval during battery charging)		
32V			
(d)	Minimum supply voltage (for operation after "Isolate relay" engaged)		
19V			
(e)	Minimum supply voltage for battery isolate relay to engage.		
22V			
(f)	Battery Discharge Indicator steady state trip voltage.		23.3V
Calibrated			
(g)	Motor Voltage Rollback "Battery Saver"	21	-
19V			

11.3 Logic Supply Current (see note 1)
300mA max

11.4 Motor drive or braking current (each channel)

- (a) Maximum controlled current (Current limited);
60A +/-5A
- (b) PWM frequency;
20kHz +20%, -10%

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11.5 Thermal rollback and cutout protection

- (a) Rollback trip (case temperature);
55 deg C
- (b) Cutout temperature (case temperature);
70 + 10, -5 deg C
- (c) Time to reach cutout limit, (at 25 Deg ambient temperature, motor stalled);
2 Mins minimum

11.6 Joystick interface parameters (refer note 2)

1. Speed channel
 - (a) Neutral offset;
+/- 30mV max
 - (b) Maximum input voltage, FORWARD;
1.00V
 - (c) Absolute max input voltage, FORWARD;
1.06V
 - (c) Maximum input voltage, REVERSE;
- 1.10V
 - (d) Absolute max input voltage, REVERSE;
- 1.25V
 - (e) Transfer function;
Customisable. See Set Up Box manual
 2. Direction channel
 - (a) Neutral offset;
+/- 30mV max
 - (b) Maximum input voltage, left & right;
+/- 1.13V
 - (c) Absolute max input voltage, left & right;
+/- 1.25V
 - (d) Transfer function;
Customisable. See Set Up Box manual
- Fehler! Textmarke nicht definiert.**
3. Reference & Supply Rail
 - (a) 12V rail voltage;
12V +/- 4%
 - (b) 12V rail output current;
20 mA max
 - (c) 6V REF voltage;
12V rail/2 +/- 1%
 - (d) 6V REF input & output current;
+/- 1 uA max

11.7 Fuse Holders

Logic Supply Fuse Rating;

2A

11.8 Parking Brake Outputs

(a) Maximum continuous current (high side source);
1.2A

(b) Operating delay (after motor V = 0);
0.2 Sec

11.9 Output connectors

(a) Battery;
4/5 pin Beau Male

(b) Motors and Parking brakes;
4/5 Pin Beau Female

(c) Programming input;
7 Pin DIN

(d) Remote;
14 pin AMP CPC

11.10 Dimensions

(a) Height 163mm

(b) Length 280mm

(c) Thickness 57mm

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11.11 Environmental

(a) Operating temperature range;
-10 to 50 Deg C

(b) Storage temperature range;
-35 to 60 Deg C

(c) Humidity (relative);
10 to 80%

(d) Enclosure rating;

Splash proof

12.0 APPENDIX 2: RECOMMENDED REMOTE SPECIFICATION

12.1 Configuration

It is recommended that the remote used with the DM60-GM controller is to have the following user controls: joystick, on-off switch, high intensity incandescent lamp to indicate on-off, BDI and error status, and a maximum speed control. A battery gauge or voltmeter is also recommended.

12.2 Joystick

The joystick is to be a fully proportional, 2 axis inductive Flightlink model.

- (a) Type number; JS4XTDC
- (b) Restrictor Plate; Flat diamond

13.0 APPENDIX 3: ASSOCIATED INFORMATION

The following documents can be used in conjunction with the Programmer when programming a DM60-GM:

1. DM Series Controller Feature Curves:
Reference number 25179
2. Programmer Operating Manual:
Reference number 25181

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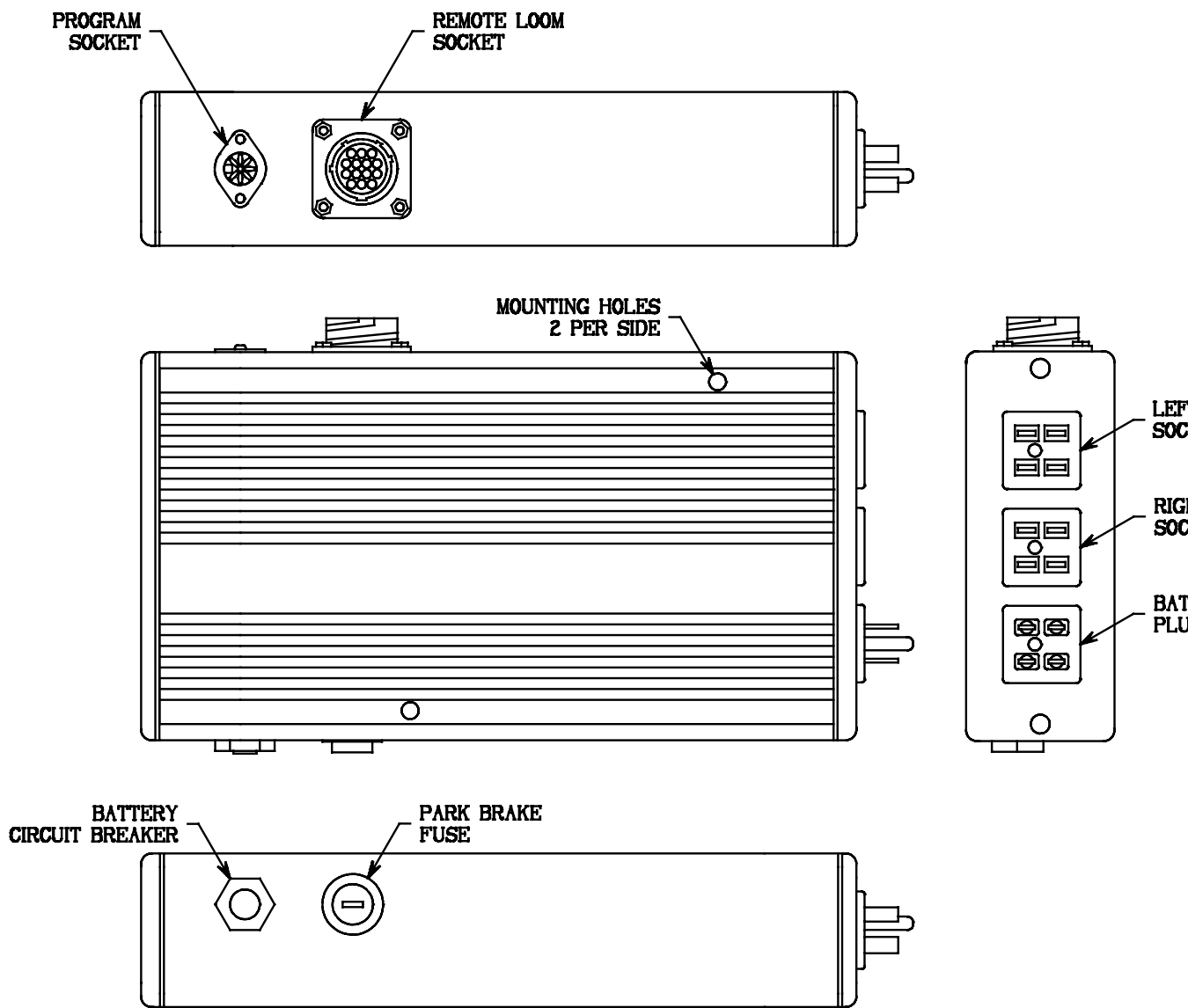
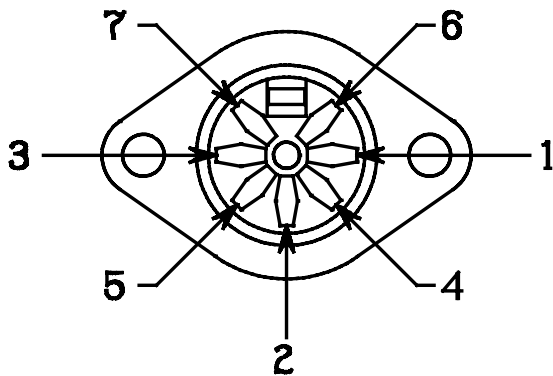


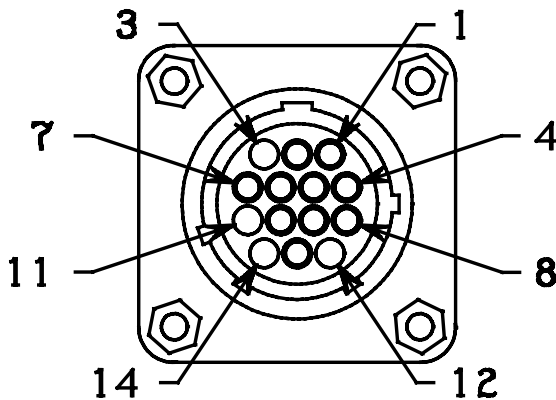
Figure 0. DM60-GM CONTROLLER CONFIGURATION

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PIN	DESCRIPTION
1	GROUND
2	SWITCHED 24V
3	INHIBIT
4	GROUND
5	NC
6	SERIAL CLOCK
7	SERIAL DATA

PROGRAM SOCKET

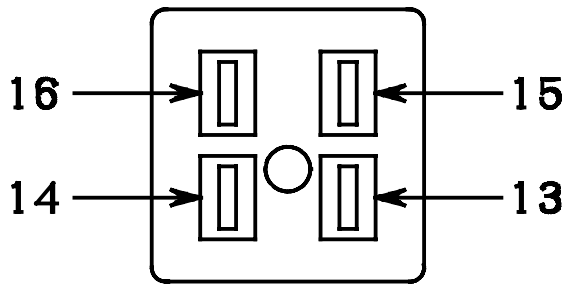


PIN	DESCRIPTION
1	SWITCH 1
2	JOYSTICK +12V
3	NC
4	JOYSTICK SPEED
5	JOYSTICK +6V
6	JOYSTICK DIRECTION
7	SWITCH 2
8	POT SPEED
9	SWITCH LAMP
10	JOYSTICK GROUND
11	NC
12	NC
13	SCREEN
14	NC

REMOTE LOOM SOCKET

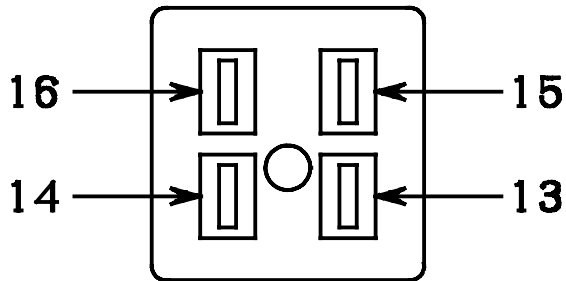
Figure 0A. DM60-GM CONNECTOR PINOUTS (PART A)

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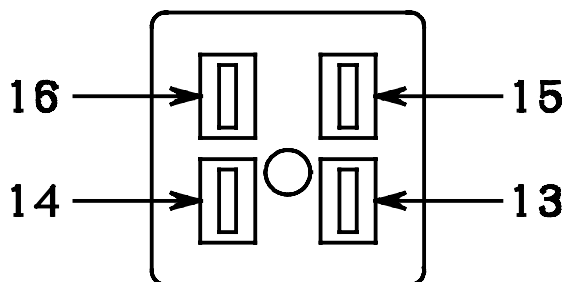
PIN	DESCRIPTION
13	BATTERY + FUSE
14	BATTERY -
15	MOTOR +
16	MOTOR -

LEFT MOTOR SOCKET



PIN	DESCRIPTION
13	BATTERY + FUSE
14	BATTERY -
15	MOTOR -
16	MOTOR +

RIGHT MOTOR SOCKET



PIN	DESCRIPTION
13	BATTERY +
14	BATTERY +
15	BATTERY -
16	BATTERY -

BATTERY PLUG

Figure 3B. DM60-GM CONNECTOR PINOUTS (PART B)

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