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 17.1 This Charger is a precision instrument intended to be operated by personnel qualified in the servicing of aircraft, industrial or medical batteries.29

 17.2 JFM Engineering’s responsibility is limited to the repair/replacement of any malfunctioning part of the system (not responsible for any losses incurred from the usage of the system).29

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1. INTRODUCTION AND SYSTEM DESCRIPTION

- The MFC-10 Charger is a microprocessor based, fully automated precision equipment for charging batteries used in Aircraft, Industrial, Medical and other applications where it is required to charge batteries as specified by the battery manufacturer or as required.
- The MFC-10 Charger can be used as a standalone charger, connected to a battery charging hub, computer controlled via JFM's BTAS-16 software or computer controlled via user developed software.

2. GLOSSARY

- Battery Manual: General Technical information provided by a manufacturer applicable to a series of batteries.
- Battery Test Profile: A specific group of parameters for a specific type of test (e.g., Time, Current and Voltage for a Capacity Test).
- BTAS16: A computerized Battery Test System
- CMM: Technical information provided by a manufacturer for a specific battery (Component Maintenance Manual)
- CPU: Central Processor Unit that under program control, processes commands to govern and monitor the operation of the instrument
- C-SCAN: A Data Acquisition Terminal (part of the BTAS16)
- Electrolyte Level Test: As applied to Nickel-Cadmium cells that have a vent cap, the process of verifying the level of the electrolyte and the addition of distilled water as required (Note that this test is performed only at the end of a charge cycle).
- Lead-Acid: Chemistry system of batteries used for most stand-by applications and for applications demanding less severe discharge currents (as compared with Nickel-Cadmium).
- Main Charge: As applicable to Nickel-Cadmium batteries, the C/2 charge current that provides 100% of the A-hr rating
- Nickel-Cadmium: Chemistry system of batteries as used in aviation and other heavy duty applications.
- Non-Volatile Memory: Memory area in the microprocessor where certain options can be stored that will remain even if the power is turned off.
- Overhaul: The process of disassembly of all interconnections, cleaning/replacement of interconnecting hardware, removal of cells and cleaning of cells and the interior of the battery. As applied to batteries that are made up from an interconnection of multiple cells.
- SLA: Sealed Lead-Acid Battery
- Thermal Runaway: Destructive condition under constant voltage charging where one cell fails and heats up and causes all other cells to fail by transmission of heat from one cell to the next. The drop in internal voltage causes an increase in charge current that intensifies the heating, thus accelerating the process.
- Topping Charge: As applicable to Nickel-Cadmium batteries, the C/10 charge current that provides 40% of the A-Hr rating (after the Main Charge)
- VRLA: Valve Regulated Lead-Acid Battery

3. CONDENSED OPERATING INSTRUCTIONS

CAUTION: Disconnect power and batteries before performing any internal maintenance. Failure to observe this caution may result in serious damage to the unit and injury to the operator.

3.1 Power ON

3.1.1. Turn Main Power ON with switch on rear panel.

3.1.2. Wait for the power-up cycle to be completed (ends with beep)

3.1.2.1. Initial Screen

```

MFC-10
JFM Engineering
Program Version 1.01
January 26 2017
  
```

Figure 1 – Initial Screen

3.1.2.2. Main Menu

```

Main Menu
→Run
Setup
Profiles
  
```

Figure 2 – Main Menu

3.2 Use Down Arrow to Select the Setup Menu and Press OK to enter

```

Main Menu
Run
→Setup
Profiles
  
```

Figure 3 – Enter Setup Menu

3.3 Scroll up and down in Setup Menu to Setup the Charger for the Desired Charge Operation

```

Setup
→Mode      Dual Rate
Time 1     02:00
Curr 1     2.0
  
```

Figure 4 –Setup Menu

- 3.3.1. **Menu will Scroll up and down as the Up and Down arrows on the key pad are pressed.**

```
Setup
Curr 1    2.0
→Volt 1   30.0
Time 2    00:08
```

Figure 5 –Setup Menu Scroll

- 3.3.2. **Pressing to the right on any entry will allow you to adjust it**

```
Setup
Curr 1    2.0
Volt 1   →30.5
Time 2    00:08
```

Figure 6 –Setup Menu - Change Entry

- 3.3.3. **Pressing the X button or the Left button will cancel any changes and move the cursor back to the left in the menu.**

```
Setup
Curr 1    2.0
→Volt 1   30.0
Time 2    00:08
```

Figure 7 –Setup Menu - Cancel Entry Change

- 3.3.4. **Pressing the OK button will save the change (confirmed with buzzer beep) and move the cursor back to the left in the menu.**

```
Setup
Curr 1    2.0
→Volt 1   30.5
Time 2    00:08
```

Figure 8 –Setup Menu - Confirm Entry Change

3.4 Available Modes are:

Mode is controlled by the first menu item in the Setup menu, which is aptly labeled mode.

3.4.1. Sing Rate - Single Rate Charge is a constant current charge for defined amount of time. Overvoltage level will cause test to end in the event the battery voltage rises too high before end of charge.

3.4.1.1. Enter value for Time, Curr and Volt

3.4.2. Peak Stop - Constant current rate charge which stops when defined voltage is reached.

3.4.2.1. Enter value for Time, Curr and Volt

3.4.3. Const Vol - Constant voltage charge, will apply a constant voltage to the battery. The current setting controls for the maximum current that will be applied.

3.4.3.1. Enter value for Time, Curr and Volt

3.4.4. Dual Rate - Dual Rate Charge is a constant current charge for a defined amount of time which then transfers to a secondary constant current charge for a second defined amount of time. Voltage settings define the Overvoltage threshold during the two stages.

3.4.4.1. Enter value for Time 1, Curr 1, Volt 1, Time 2, Curr 2 and Volt 2

3.4.5. Dual w/Pk - Dual Rate Charge with Peak Transfer is a constant current charge until a programmed battery voltage is reached, then followed by a secondary constant current charge for a programmed amount of time. The second voltage setting defines an Overvoltage.

3.4.5.1. Enter value for Time 1, Curr 1, Volt 1, Time 2, Curr 2 and Volt 2

3.5 Once Setup is Complete

3.5.1. When you have finished selecting all of the relevant parameters for your charge operation you can return to the Main Screen using the X button.

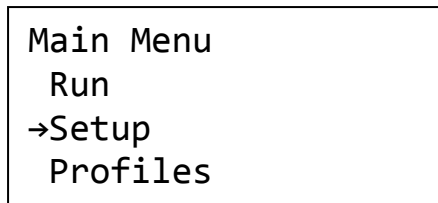


Figure 9 –Setup Menu - Leave Menu

3.6 Connect the Battery

- 3.6.1. Observe Polarity when using clips!
- 3.6.2. Verify the battery voltage reading in the voltmeter

3.7 Running the Charger

- 3.7.1. Select the Run Menu Item and press OK

```

Main Menu
→Run
→Setup
Profiles
  
```

Figure 10 –Run Menu Item

- 3.7.2. You will then be asked to Confirm your setting.

```

Sing Rate Confirm?
T : 00:20
C : 10.0
V : 13.7
  
```

Figure 11 –Confirm Charger Settings

- 3.7.3. Press OK to confirm your setting and the charge operation will begin.

```

Sing Rate
Time: 00:00:01
Voltage: 12.3
Current: 10.0
  
```

Figure 12 –Charge Operation Running

3.8 Press X to Stop the charge operation

- 3.8.1. Press X to stop the operation
- 3.8.2. This will put the test on hold

```

Sing Rate
Time: 00:00:01
Voltage: 12.3
Current: 0.0
  
```

Figure 13 –Placing a charge operation on hold

- 3.8.3. Press OK to resume operation or press X again to return to the main Menu

4. SPECIFICATIONS

4.1 Charge

4.1.1. **Maximum Current: 10A**

4.1.2. **Minimum Current: 0.0A**

4.1.3. **Resolution: 0.1A**

4.1.4. **Accuracy: $\pm 0.1A$**

4.1.5. **Maximum Voltage: 38V**

4.2 Test Modes

4.2.1. **Single Rate Constant Current Charge with Overvoltage**

4.2.2. **Single Rate Constant Current Charge with stop at Peak Voltage**

4.2.3. **Current Limited (constant current) Constant Voltage Charge**

4.2.4. **Dual Rate Constant Current, Charge with optional Overvoltage**

4.2.5. **Dual Rate Constant Current, with transfer at Peak Voltage and optional Overvoltage**

4.3 Protection

4.3.1. Open Circuit

4.3.1.1. Absolute Overvoltage sensing

4.3.2. Short Circuit

4.3.2.1. Current limited by programming

4.3.3. Reverse Polarity

4.3.3.1. 0.25V minimum voltage

4.3.4. Main Power fuses

4.3.4.1. Line input (mains) fuse

4.3.4.2. Power Supply

4.3.5. Limiter

4.3.5.1. Charge Limiter: 10A Slow Blow

4.3.5.2. Note: operation with fuses of rating and types different from indicated may result in damage to charge circuits (voiding the warranty).

4.4 Environmental

4.4.1 Ambient Temperature:

4.4.1.1. 5°C to 35°C (41°F to 95°F)

4.4.2 Relative Humidity:

4.4.2.1. 95%, non-condensing

4.4.2.2. Note: High ambient humidity can lead to corrosion of contacts and other parts.

4.4.3 Altitude:

4.4.3.1. N/A

5. CONTROLS AND DISPLAYS

5.1 Front Panel

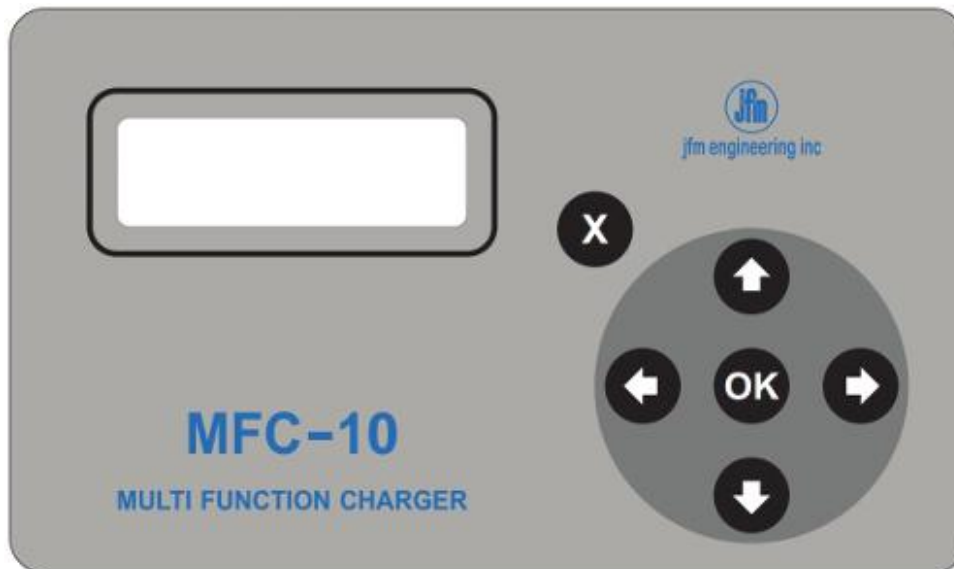


Figure 14 –Front Panel

5.1.1. LCD DISPLAY

5.1.1.1. 4X20 LCD Screen. Contrast Adjustable via potentiometer on the Control Board.

5.1.2. Control Buttons

5.1.2.1. The Keypad is composed of capacitive buttons. Buttons are calibrated at system power on.

5.2 Rear Panel

5.2.1. POWER SWITCH

- Main Power Switch
- IEC Line Cord Socket
- Line Cord Fuses

5.2.2. BATTERY CABLE CONNECTOR

- Connector for the Battery Cable
- Sensing Leads

5.2.3. CHARGE LIMITER FUSE HOLDER

- Use to access the charge limiter fuse

5.2.4. HUB CONNECTOR

- Used to connect the MFC-10 to an MFC-10 Extension Hub

5.2.5. GENERAL IO CONNECTOR

- Used to connect to various IO Cables

6. MODES OF OPERATION

6.1 Sing Rate

6.1.1. Single Rate Charge

6.1.2. Constant Current (Curr)

6.1.3. Stop at the end of the programmed time (Time) or at detection of programmed overvoltage (Volt)

6.2 Peak Stop

6.2.1. Single Rate Charge

6.2.2. Constant Current (Curr)

6.2.3. Stop at the selected Peak Voltage (Volt)

The display will indicate "End of Test" if the battery reaches the programmed peak voltage (Volt 1) or the programmed time (Time 1) has passed.

6.3 Const Volt

6.3.1. Constant Voltage Charge

6.3.2. Constant Current (Curr) initially then transition to Constant Voltage (Volt)

6.3.2.1. The transition is dependent on the magnitude of the programmed voltage and current (from approximately 0.25V to 0.5V)

6.3.3. Stop at the end of the programmed time (Time)

6.4 Dual Rate

6.4.1. Dual Rate Charge

Automatic transition from current 1 (Curr 1) to current 2 (Curr 2) at the programmed time interval (Time 1)

6.4.2. Stop at the end of the selected time (Time 1 + Time 2) or at detection of a programmed overvoltage (Volt 1 or Volt 2 depending on time interval)

6.5 Dual w/Pk

6.5.1. Dual Rate Charge with Peak Transfer

6.5.2. Transfer on Peak from Main to Topping

Automatic transition from current 1 (Curr 1) to current 2 (Curr 2) at the detection of the programmed peak voltage (Volt1)

Note: If the peak voltage is not reached, the transition is based on the programmed time (Time 1)

6.5.3. Charging will then stop at the end of the time 2 duration (TIME 2) or at the detection of an overvoltage (Volt 2).

7. PROFILES MENU

7.1 General

The profiles menu is provided to allow the user to save battery settings profiles for loading at a later time. All profiles are stored in EEPROM memory, which allows for them to be recalled even after the charger has been power cycled. The MFC-10 allows for up to 40 profiles to be saved.

7.2 Profiles Menu

```

Profiles Menu
→Load Profile
  Save Profile
  View Profile
  
```

Figure 15 –Profile Menu - Select Menu Item

Select the desired operation and press the OK button.

The cursor will then advance to the right.

```

Profiles Menu
  Load Profile   →01
  Save Profile
  View Profile
  
```

Figure 16 –Profile Menu - Select Profile to Load

Use the up and down arrows to select the desired profile and click OK to Load, Save or View the profile. The X button can be used to cancel an operation.

7.3 Load Profile

Load Profile will load the selected profile into the current settings.

7.4 Save Profile

Save profile will save the current profile to the selected profile number

7.5 View Profile

View profile will display the setting stored in the selected profile.

8. OPTIONS MENU

8.1 General

The options menu allows the user to adjust the various settings of the charger.

8.2 Options Menu

```
Options
→Back Light   On
Test Mode     Off
Comm Mode     BTAS
```

Figure 17 - Options Menu - Select Option

Select the desired option and press the → button.

The cursor will then advance to the right.

```
Options
Back Light   →Off
Test Mode     Off
Comm Mode     BTAS
```

Figure 18 –Options Menu - Change Option

Use the up and down arrows to select the desired option setting and press OK to save the option setting. The X button can be used to cancel a change.

8.3 Back Light

Selects weather the back light is On or Off.

8.4 Test Mode

Selects weather Test Mode is On or Off. When On Tests will run at 60 times (one min = one sec) the saved rate. Leave Off for normal operation.

8.5 Comm Mode

This Options allows the user to select BTAS or Direct Comm operations. More details can be found in section 10.

8.6 CID

Allows for the Charger ID to be set. Applicable when used with BTAS software.

8.7 Show Time

When this option is set to True the date and time will be shown on the main menu screen.

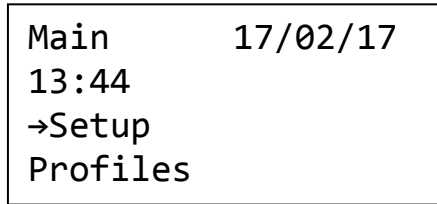


Figure 19 –Main Menu with Time Shown

8.8 Set D/T

Select this menu item to set the date and time values. Once selected follow the steps displayed on the screen to set the date and time.

8.9 CLK Dft Adj

The menu item will allow you to compensate for any drift in the clock of your charger. First observe the amount of drift in the clock of your charger over a twenty four hour period and then enter it in this menu item. The real time clock in the charger will then compensate for the observed clock drift.

8.10 Show Volt

When this option is set to True voltage will be shown on the main menu screen.

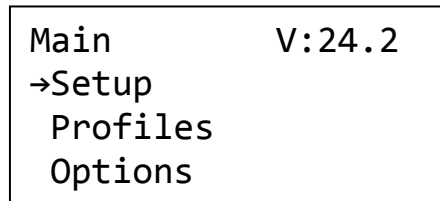


Figure 20 –Main Menu with Voltage Shown

9. CALIBRATION MENU

9.1 General

The calibration menu allows the user to step through the calibration process of the charger. Calibration involves four steps and requires the use of a calibrated volt meter, a calibrated amp meter and a battery to apply a measured charge to.

9.2 Options Menu

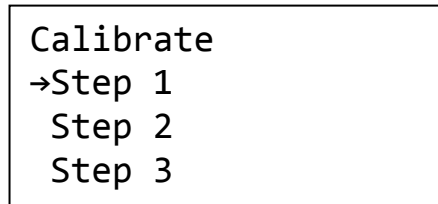


Figure 21 –Calibration Menu

Select the desired calibration step and press the OK button.

Information on completing the selected step will then appear.

9.3 Step 1

Step 1 is to calibrate the unit's mid current range.

Set up the charger so it is hooked to a battery though a calibrated current meter.

Select step 1 and press OK. Instructions will appear on the screen.

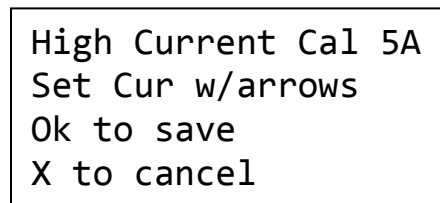


Figure 22 – Step 1 of Calibration

With the instruction screen shown press the up arrow until the connected calibrated current meter reads 5.00 Amps. The down arrow can be used to adjust the current back down if it has been adjusted past 5.00 Amps.

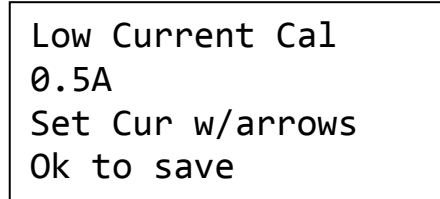
With the charger delivering 5 amps press the OK button to complete this step. The X button can be used to cancel out of this step without changing the unit's calibration settings.

9.4 Step 2

Step 2 is to calibrate the unit's low current range.

Set up the charger so it is hooked to a battery though a calibrated current meter.

Select step 2 and press OK. Instructions will appear on the screen.



```
Low Current Cal
0.5A
Set Cur w/arrows
Ok to save
```

Figure 23 – Step 2 of Calibration

With the instruction screen shown press the up arrow until the connected calibrated current meter reads 0.50 Amps. The down arrow can be used to adjust the current back down if it has been adjusted past 0.50 Amps.

With the charger delivering 0.50 amps press the OK button to complete this step. The X button can be used to cancel out of this step without changing the unit's calibration settings.

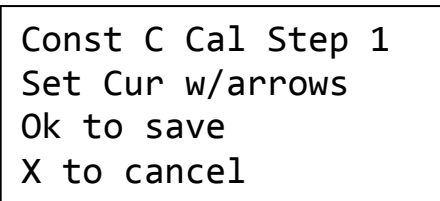
9.5 Step 3

Step 3 is to calibrate the unit's mid-range voltage reading.

Set up the charger so it is hooked directly to a battery and the battery is being measured by a calibrated volt meter.

Also make sure that the **Volt 1** (or **Volt**) setting under the setup menu is set to a value that is reasonable to make the attached battery charge at constant current. (eg. 2V above its current voltage.)

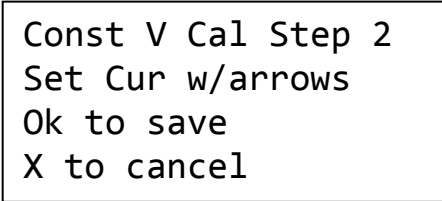
From the calibration menu then select step 3 and press OK. Instructions will appear on the screen.



```
Const C Cal Step 1
Set Cur w/arrows
Ok to save
X to cancel
```

Figure 24 – Step 3 of Calibration Step1

With the instruction screen shown press the up arrow until the battery voltage begins to climb above the **Volt 1** (or **Volt**) setting. The down arrow can be used to adjust the current back down if it has been adjusted too high. Press OK to proceed to the next step.



```
Const V Cal Step 2
Set Cur w/arrows
Ok to save
X to cancel
```

Figure 25 – Step 3 of Calibration Step2

Now use the down arrow to limit the charging voltage of the charger to the battery. Once the battery is being held at the voltage set **Volt 1** (or **Volt**), press OK to save the settings.

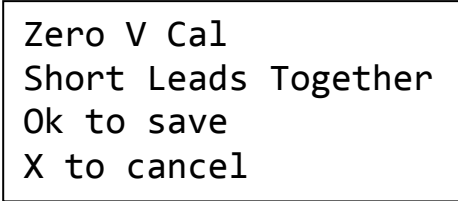
You can use the X button to cancel out of this step at any time.

9.6 Step 4

Step 4 is to calibrate the unit's Zero voltage reading.

Connect the positive and negative outputs of the charger together.

From the calibration menu then select step 4 and press OK. Instructions will appear on the screen



```
Zero V Cal
Short Leads Together
Ok to save
X to cancel
```

Figure 26 –Step 4 of Calibration

With the outputs shorted together press OK to save the calibration reading.

You can use the X button to cancel out of this step at any time.

10. COMP CONTROL MODE

10.1 General

The Computer Control Mode menu item, when selected, allows for a connected computer to take control of the charger.

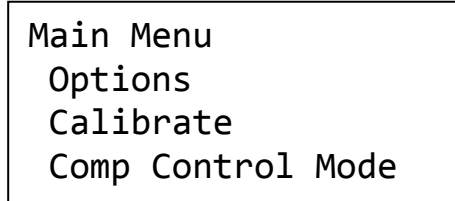


Figure 27 –Comp Control Mode Menu Item

When selected the charger will either go into BTAS or Direct Comp Control modes, based on the setting selected in the options menu.

10.2 BTAS Mode

The MFC-10 can be used with the BTAS-16K software if directly connected to the host BTAS-16K computer by a MFC-10 USB cable, but will be the only charger able to be controlled by the BTAS-16K software.

Alternatively the MFC-10 can also be connected to the BTAS network with a BTAS network adapter. This approach allows the MFC-10 to be one of up to 16 chargers.

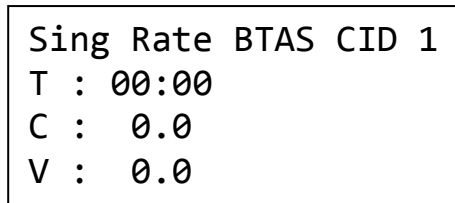


Figure 28 –BTAS Comp Control Screen

10.3 Direct Mode

Direct Mode is designed to allow users to create custom applications for the MFC-10. A computer can be connected to the MFC-10 by way of its built-in USB com port. Once connected to a computer the MFC-10 can be interfaced with via a 19200 BAUD,8,1,None serial connection.

Once connected the MFC can be controlled by the following commands:

To set the Charge Enable pin:

```
~00LSETCEXXXXXXXXXXXXXXXXXXXXXZ
```

To clear the Charge Enable pin:

```
~00LCLRCEXXXXXXXXXXXXXXXXXXXXXZ
```

To control the Voltage Setting (scale of 0-400 for 0 to 40Volts)

```
~00LSETVL__XXXXXXXXXXXXXXXXXXZ
```

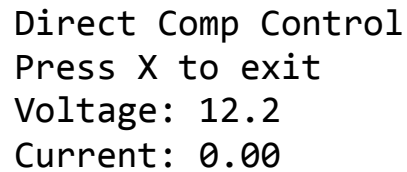
To control the Current Setting (scale of 0-100 for 0 to 10Amps)

```
~00LSETCL__XXXXXXXXXXXXXXXXXXZ
```

To read current and voltage data from the MFC

```
~00LGETVCXXXXXXXXXXXXXXXXXXXXXZ
```

Response format is 'C: 0000 V: 000 where current value is given to the 0.01 Amp resolution and V is given to the 0.1 Volt resolution.



```
Direct Comp Control
Press X to exit
Voltage: 12.2
Current: 0.00
```

Figure 29 –Direct Comp Control Screen

11. CHARGING HUB MENU

11.1 General

The Charging hub menu allows the MFC-10 to control an attached charging hub. Consult the charging hub manual for further details.

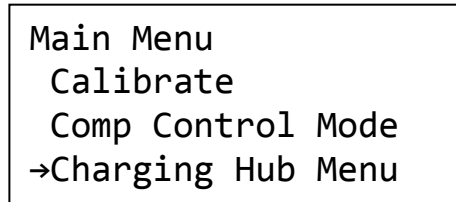


Figure 30 –Charging Hub Menu Item

12. OPERATING NOTES AND PRECAUTIONS

CAUTION: Disconnect power and batteries before performing any internal maintenance. Failure to observe this caution may result in serious damage to the unit and injury to the operator.

- 12.1 The negative side of the battery cable is connected to chassis ground. Avoid connecting to other equipment where there may be grounding connection incompatibilities. There could be damage due to high current or current path errors.**
- 12.2 Observe Polarity when connecting the charger to a battery or cells.**
- 12.3 Do not start the instrument until a proper connection to a battery or cells has been established.**
- 12.4 Do not disconnect the battery cable from the battery while charging (severe damage due to arcing may occur).**
- 12.5 Operation in dusty environment will reduce the cooling efficiency of the unit's fan.**
 - Failure to observe this precaution could result in the unit over heating during operation.

13. INSTALLATION

13.1 Bench Space

The MFC is designed to be highly portable. It is important that it be placed on a safe and secure surface while the unit is in operation. Also, it is important that the fan and vents on the rear of the unit are not obstructed during its operation.

13.2 Line Voltage (mains)

The MFC-10 has a universal power supply and can be operated connected to a mains voltage of between 100VAC and 240VAC and at a frequency of 50Hz or 60Hz.

14. UPDATES

- 14.1 For firmware updating (control program), the unit will need to be sent to JFM Engineering. Contact JFM Engineering for more information.

15. TROUBLESHOOTING AND REPAIRS

CAUTION: Disconnect power and batteries before performing any internal maintenance. Failure to observe this caution may result in serious damage to the unit and injury to the operator.

The following are hints and directions to help you locate the most probable causes of deviation of performance as established in the procedures of section [**Error! Reference source not found.**] Verification of Performance.

15.1 Error Messages

15.1.1. "AOV!"

Battery voltage has reached a level above the absolute maximum rating of the charger (38V). This can occur when charging a faulty battery or starting a charge operation without the battery connected.

15.1.2. "RP FAULT!"

Connection to the battery with the polarity reversed [see **Error! Reference source not found.**]

15.1.3. "V Flt"

Battery has exceeded the overvoltage setting for the charge operation.

15.1.4. "C Flt"

The charger is not running at the current set in the Setup menu.

15.1.5. "OHeat"

Charge has overheated. Charger internal temperature is too high. Place charger in cooler environment while running.

15.1.6. "CLF!"

Charge Limiter Fault. The charge fuse is discontinuous. Check to see if the charging fuse is still intact.

15.1.7. "VSF!" or "SUPP FLT!"

Voltage supply fault. The main voltage supply is not producing the correct voltage. This will occur in the event that there is a mains power interruption.

15.2 Troubleshooting

15.2.1. Misc:

15.2.1.1. Starts but stops in one second.

Time not programmed (zero).

15.2.1.2. Starts but there is no current.

- Current not programmed (zero)

- Battery(ies) not connected

16. BATTERY TESTING NOTES

Note: Battery testing is a hazardous operation. Handle batteries with extreme care as they are capable of very high discharge currents if short circuited.

Check the Battery Manual, CMM or Aircraft Manufacturer Instructions for information on charging, discharging and testing.

For Nickel-Cadmium batteries, the most effective charge method is constant current vs. time. In the absence of any particular instructions from the manufacturer, charging at $C/10$ for 12 to 16 hours will insure a complete charge.

Specifically for main batteries, the typical charge profile is $C/2$ for 2 hours followed by $C/10$ for 4 hours.

The Nickel-Cadmium batteries can also be charged in the float mode, with a voltage of 1.4 V/cell (a 20 cell battery would be set to 28.0V).

The Charge & Float and the Charge & Peak Stop modes are particularly useful with lead acid batteries, where the battery voltage is a better indicator of the state of charge, as compared with Nickel-Cadmium batteries where terminal voltage gives much less information on the state of charge.

Lead-Acid batteries are normally float charged (constant voltage) typically at 2.33V/cell. A 6 cell pack (12V) will then be float charged with the voltage programmed at 13.8V. In this mode, the charge current is set to the highest level that the cells will safely take (typically up to 1C depending on the battery type and specific instructions from the manufacturers). This will be the charge current until the float voltage is reached, at which time the current will diminish to the level needed to maintain the programmed float voltage.

Lead-Acid batteries can also be charged in a manner in which it is possible to know much better the end of charge. When a Lead-Acid cell is charged with constant current at $C/15$ to $C/10$, the end voltage will rise rapidly at about 90 to 95% of charge, which occurs at about 2.4 to 2.45V/cell. A 5A-hr, 6 cell battery can be charged at 335mA to 500mA, with the peak voltage programmed at 14.7V. The Instrument will stop the charge operation when the rapid rise of end-of-charge voltage is detected.

17. DISCLAIMER

17.1 This Charger is a precision instrument intended to be operated by personnel qualified in the servicing of aircraft, industrial or medical batteries.

17.2 JFM Engineering's responsibility is limited to the repair/replacement of any malfunctioning part of the system (not responsible for any losses incurred from the usage of the system).

17.3 User's Responsibility

- It is the user's responsibility to verify suitability in the intended application.
- It is the user's responsibility to verify the performance of the instruments and to operate and maintain it in accordance with the above given instructions.
- It is the user's responsibility to test batteries in accordance to the instructions and recommendations of the manufacturers of the batteries.
- It is the user's responsibility to operate the Instrument within standard safety procedures applicable to the operation of a Battery Test Facility.
- It is the user's responsibility to install power receptacles and wiring in accordance with local wiring codes.
- It is the user's responsibility to observe all necessary precautions and to be equipped with personal protective equipment when working with batteries to avoid injury due to electrolyte splashing, short circuits with tools and to avoid injury due to the size and weight of the batteries.
- It is the user's responsibility to verify the integrity of the performance of this instrument in accordance with the instructions of Section 12.
- It is the user's responsibility to operate this instrument within the limits and guidelines as described in the Precautions and Installation sections.
- It is the user's responsibility to properly package the instrument for shipping whenever factory service is required.

18. REVISION INDEX**Table 1 - Index of Revisions**

| REVISION | DATE | NOTES |
|-----------------|-----------------|---|
| 1.0 | 26 January 2017 | Preliminary release |
| 1.e | 12 April 2017 | Text and paragraph style corrections by jfm |
| | | |

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