

# MFJ

## *Super Battery Booster*

*Model MFJ-4416C*



### INSTRUCTION MANUAL

CAUTION: Read All Instructions Before Operating Equipment

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**INTRODUCTION & FEATURES**

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**INTRODUCTION**

The MFJ-4416C Super Battery Booster is designed with the serious mobile operator in mind. In the mobile environment low battery voltage can cause output signal distortion, output power problems and even transceiver resetting. This low voltage occurs in two ways. First – even low resistance wiring can result in noticeable voltage drop. And second when you turn off your vehicle or remove a typical battery from the charger, the battery voltage can drop from the nominal 13.8 volts to 12 volts after a short period of time. With this in mind the MFJ-4416C Super Battery Booster corrects all of these problems. With its high efficiency boost regulator circuitry, it will maintain the desired 13.8 volts at up to 25 amps ICAS from voltages as low as 9 volts.

The MFJ-4416C has been redesigned to make the device more robust with heavy duty transistors and rectifiers, improved switch mode transformer, and larger heatsinks on vital components. The EMI filters on the input and output of the MFJ-4416C are designed to reduce noise to a minimum so radio reception while on is normally no problem.

**FEATURES**

**Choice of Input and Output Connections:** No need to fumble around looking for connectors. The MFJ-4416C gives you a choice of Anderson PowerPole™ connectors or 5-way binding posts on the input and output.

**Adjustable Output Voltage:** User adjustable output voltage. Factory set at 13.8 volts this voltage is adjustable anywhere from 12 to 13.8 volts.

**Selectable Minimum Input Voltage:** You have the choice of the minimum input voltage the MFJ-4416C will operate on. Set from the factory at 10 volts you can select 9 or 11 volts. This keeps you from possibly over discharging your battery and damaging it. It is even latchable so once the voltage drops the Boost Regulator stop until you remove the power from the unit.

**Audio Alert Feature:** When enable instantly alerts you when the input voltage drops below the preset level.

**External Boost Enable:** A DE-9 input port with 4 inputs that are used to externally enable the MFJ-4416C. Two inputs when grounded enable the unit and two inputs when taken high (10-12V) will enable the unit.

**Remote Jack:** Allows sampling of the Input Voltage and the Output Voltage. Also allows for control of the Boost Switch and has an active low output for the Low voltage alarm. Direct connection to the MFJ-4416RC Remote Unit.

**RUGGED CONSTRUCTION** - Attractive all-metal cabinet and conservative component selections ensure solid performance for years to come. Fully covered by MFJ's "No Matter What" one year limited warranty.

### **TYPICAL SPECIFICATIONS**

Output Current.....25 Amps ICAS 30A peak.

Output Voltage .....13.8 Volts at 9-13.8 volts input.

Before attempting to operate your MFJ-4416C, please read the manual thoroughly. It contains important details about setting up your unit to obtain the best performance.

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### **EASY START INSTRUCTIONS**

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1. Prepare input and the output cables for the MFJ-4416C. It is recommended to use #12 or larger wire for both the input and output cables. MFJ has cables available for the output side for use with most HF and VHF/UHF radios.
2. Prior to connecting the radio and battery, plug the input and the output cables in to the MFJ-4416C and ensure the polarity is correct.
3. Plug the output of the MFJ-4416C into your radio and then attach the input to your battery.
4. You are now ready to operate. If not using external switching, depress the enable switch.

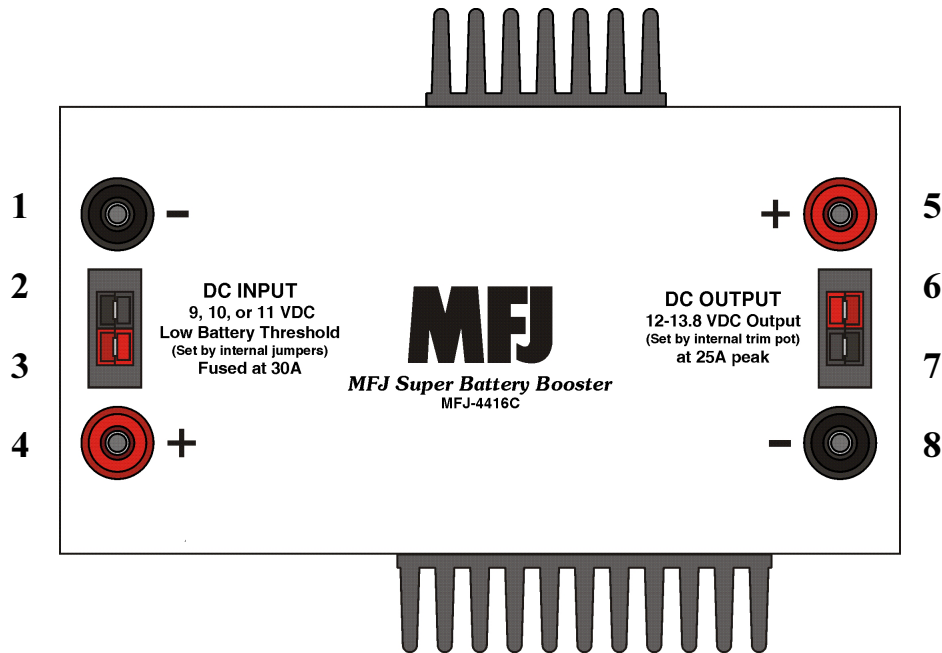
**NOTE: The MFJ-4416C is not designed to boost the voltage of a 6V electrical system up to 13V and will not run on a positive ground system. It will also not reduce the voltage of a 24V or higher system to 13V.**

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## SYSTEM CONTROLS AND INDICATORS

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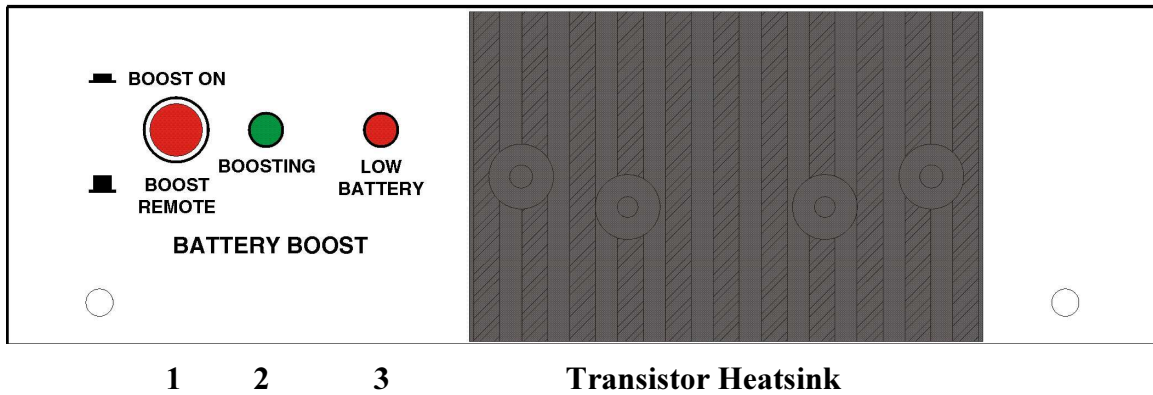
### Top Inputs and Outputs:



**Figure 1 Top View**

1. 5-Way High Power Binding Post Negative Input.
2. Anderson PowerPole™ Negative Input.
3. Anderson PowerPole™ Positive Input.
4. 5-Way High Power Binding Post Positive Input.
5. 5-Way High Power Binding Post Positive Output.
6. Anderson PowerPole™ Positive Output.
7. Anderson PowerPole™ Negative Output.
8. 5-Way High Power Binding Post Negative Output.

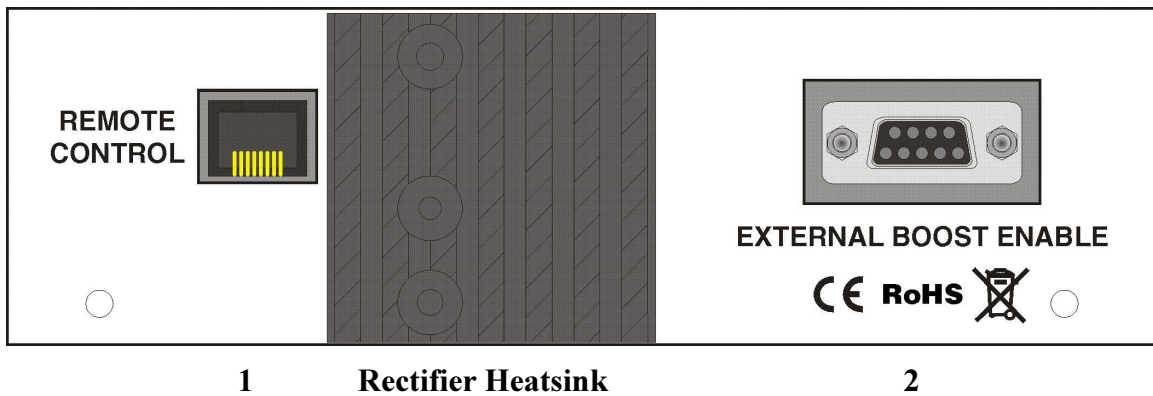
**Side A Controls and Indicators:**



**Figure 2 Side A View**

1. Boost On/Remote: This switch enables the Battery Boost function when in and when out enables the Remote Boost Enable feature.
2. Boosting LED: This LED is illuminated when the Switching Regulator is enabled either through the RF Sense feature or the Enabled/Disabled Switch is in the Enabled position.
3. Low Battery LED: The LED Illuminates the low voltage trip threshold has been crossed. If the latching feature is enabled the MFJ-4416C must be removed from the input voltage source and allowed to discharge to reset the cutout.

**Side B Controls and Indicators:**



**Figure 3 Side B View**

1. Remote Control Jack: This Jack allows the MFJ-4416BRC Remote Control and metering unit to be attached to the MFJ-4416C. This allows remote monitoring of the Input Voltage and Output Voltage. It also allows Remote Enabling and Audible alarm of the MFJ-4416C. Perfect for remote placement of the MFJ-4416C. See page 13 for model numbers.

- External Boost Enable: This connector allows remote enabling of the booster from the radio amp key line or other remote devices.

## CONNECTION AND OPERATION

### DC Power Connection:

The MFJ-4416C is designed to boost voltages as low as 9V up to 13.8V at up to 25A. At high currents the voltage drop from even large gauge wires can be appreciable for even short runs. It is recommended to use a large gauge wire (such as #8 or #10) to reduce the voltage drop. Connect the wire to the battery or other high current terminal on the vehicle for best results. Connection to the lighter jack or a smaller fuse block is not recommended because of the smaller gauge wires used in the automotive wiring harnesses. A fuse in the positive line near the battery is recommended to protect the wiring from accidental shorts circuits. Connect the radio to the MFJ-4416C using the wiring harness from the radio manufacturer. MFJ carries a number of cables that can be used for this purpose. See page 13 for model numbers.

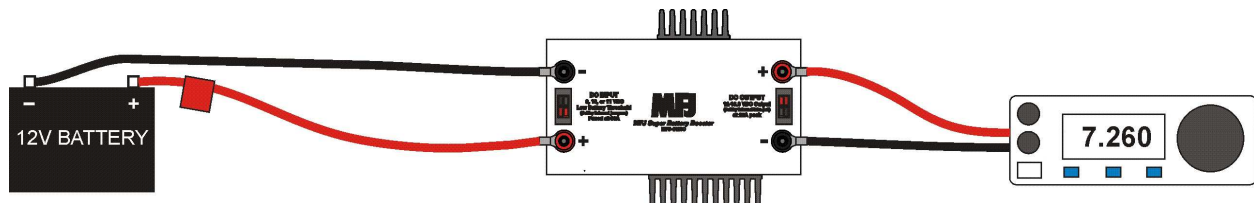


Figure 4 DC Wiring

Terminal connections to and from the MFJ-4416C can use 30A Anderson PowerPole terminals, crimp lugs, banana plugs or wires straight to the 5 way binding posts. Follow the connector manufacturers instructions for attaching the terminal lugs. Make sure the lugs are tightly crimped to insure they do not pull loose. If the binding posts are used make sure the binding posts are tightened down so the lug will not pull off the post. Wires that connect to the binding posts directly are not recommended because they can pull loose easily.

### Remote and External Control Connections:

**External Control:** The MFJ-4416C can be enabled externally through the EXTERNAL BOOST ENABLE connector allowing the unit to be enabled a number of ways including the ignition line, and the radio amplifier key line. There are a total of 4 control lines. Two will enable the MFJ-4416C when grounded and two will enable the MFJ-4416C when tied to a 4-13V source.

Connecting either pin 1 or 2 to the amplifier key line of the radio if it has one will set up the MFJ-4416C to enable only when transmitting. This will help reduce any noise that may be generated by the switching boost circuit while receiving. See your radio manual for the proper connections to the radio.

Connecting either pin 3 or pin 4 of the external control connector to an accessory line will allow the booster to be enabled when the vehicle is turned on or when it is set in accessory on the ignition switch. This will help reduce the current drain on the battery when the vehicle is off.

Not all radios are set up to be able to key the MFJ-4416C. In those cases the boost button will have to be set to ON.

**Remote Control:** The optional Remote Control MFJ-4416BRC can be used to monitor and control the MFJ-4416C allowing the MFJ-4416C to be mounted in an out of the way place in the vehicle. The connection is a normal CAT-5 cable that plugs into the MFJ-4416BRC and the MFJ-4416C REMOTE CONTROL RJ-45 Jack.

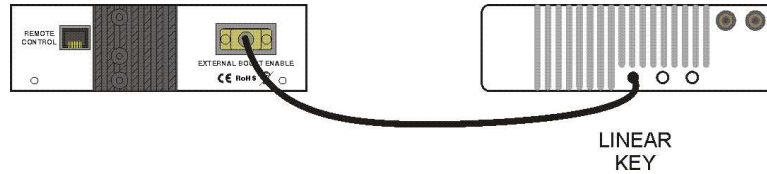


Figure 5 External Enable to Amp Key



Figure 6 Remote Control

Figure 7 Ignition Sense

EXTERNAL BOOST CONNECTOR	
DE-9 Pin	Function
1	GROUND TO ENABLE pulled to +13V with 3.3K pull-up resistor.
2	GROUND TO ENABLE pulled to +13V with 3.3K pull-up resistor.
3	HIGH TO ENABLE any voltage between 4 and 15V
4	HIGH TO ENABLE any voltage between 4 and 15V
5	13V DC OUTPUT resettable fuse limited to 100mA
6 to 9	GROUND

REMOTE CONTROL CONNECTOR	
RJ-45 Pin	Function
1	INPUT VOLTAGE, resettable fuse limited to 100mA
3	ENABLE SIGNAL, ground to enable.
5	LOW VOLTAGE ALARM SIGNAL, ground indicates alarm condition.
7	OUTPUT VOLTAGE, resettable fuse limited to 100mA
2, 4, 6, 8	GROUND



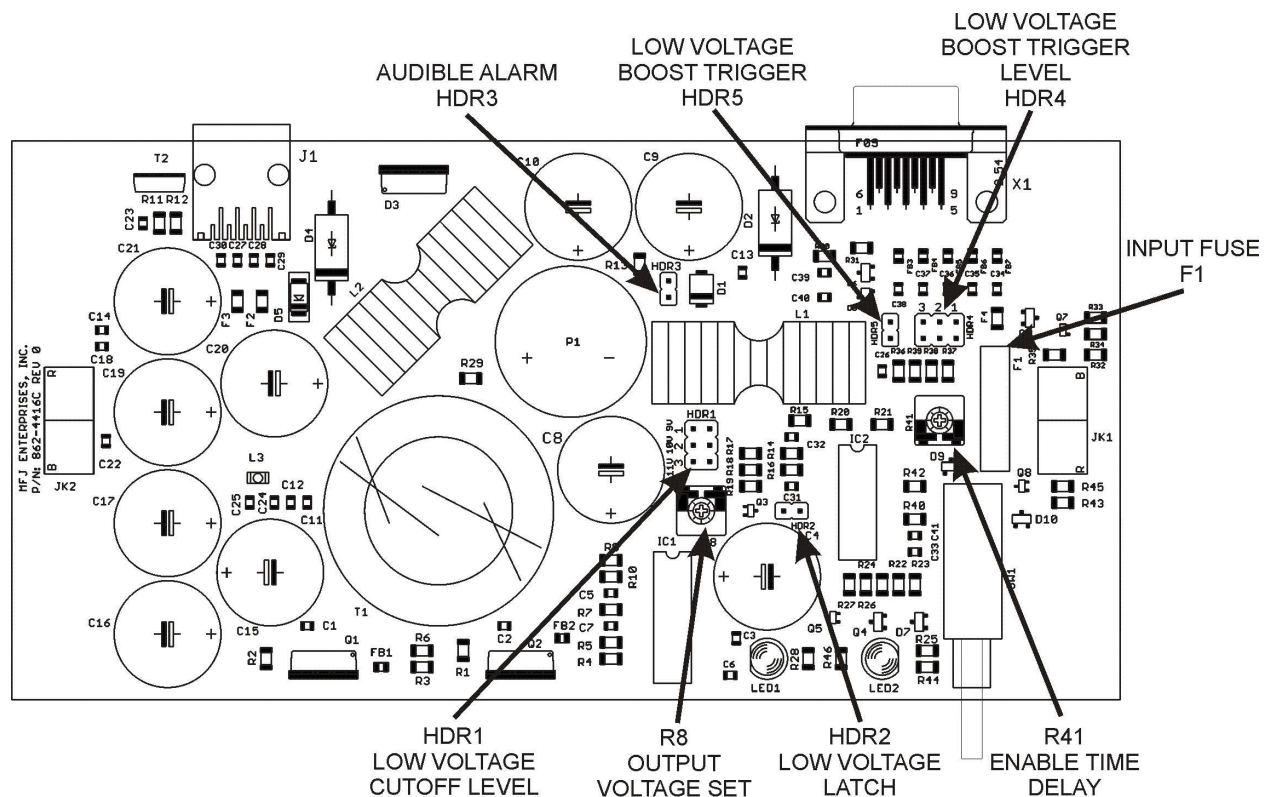
## Operation:

Once wired in the unit will boost the incoming voltage to 13.8V when enabled for any voltage between the minimum voltage and 13.8V. If the incoming voltage is above what the output voltage is set to the output voltage will rise to the incoming voltage minus about a half volt. When the MFJ-4416C is not energized the input voltage is passed to the output connectors and has about a half volt drop due to the internal rectifiers.

There are protective diodes that protect the input and output from exceeding 18V or being reverse wired.

The MFJ-4416C is not designed to boost the voltage of a 6V electrical system up to 13V and will not run on a positive ground system. It will also not reduce the voltage of a 24V or higher system to 13V.

## INTERNAL HEADER AND CONTROL



**Figure 8 Internal Jumpers and Controls**

**HDR1 Low Voltage Lockout:** This is where you set the input voltage cutout. Default is 10 volts with the jumper at 2. To set the cutout at 11 volts move this jumper to 3. For 9 volts cutout move this jumper to 1.

**HDR2 Low Voltage Lockout Enable:** When jumpered the Boost Regulator IC will be shutdown anytime the voltage drops below the level set by the Input Voltage Cutout. It will remain shutdown until the input voltage is removed from the unit. Default is not jumpered.

**HDR3 Audio Alert Enable:** This jumper enables the audio alert. Any time the voltage drops below the level set by the input voltage cutout you will be alerted by the Piezo buzzer. Default is jumpered. To disable remove the jumper.

**HDR4 Low Voltage Boost Trigger Level:** When enabled this set of jumpers sets at what voltage the boost circuit is enabled. The Default is jumper at 1 for enable at 10V, jumper at 2 for 11V enable, and jumper at 3 for 12V enable.

**HDR5 Low Voltage Boost Trigger Enable:** A jumper on this header enables the Low Voltage Boost Enable function. Default is no jumper.

**R8 Voltage Adjust:** This trimpot sets the output voltage. Set from the factory at 13.8 volts this level is adjustable from 12 to 13.8 volts. This control can be accessed through the hole in the bottom cover.

**R41 Enable Time Delay:** This control sets the time delay between when the Low Voltage Boost Trigger voltage goes above the set level and the time the boost circuit actually turns on. Default is normally about 2 seconds with the pot at mid range. This control is accessed through the fuse cover.

**F1 Fuse:** The fuse is accessible through the bottom cover by removing the two screws on the cover plate. This fuse is a 30A automotive blade type. Do not use a fuse of a higher current rating.

## THEORY OF OPERATION

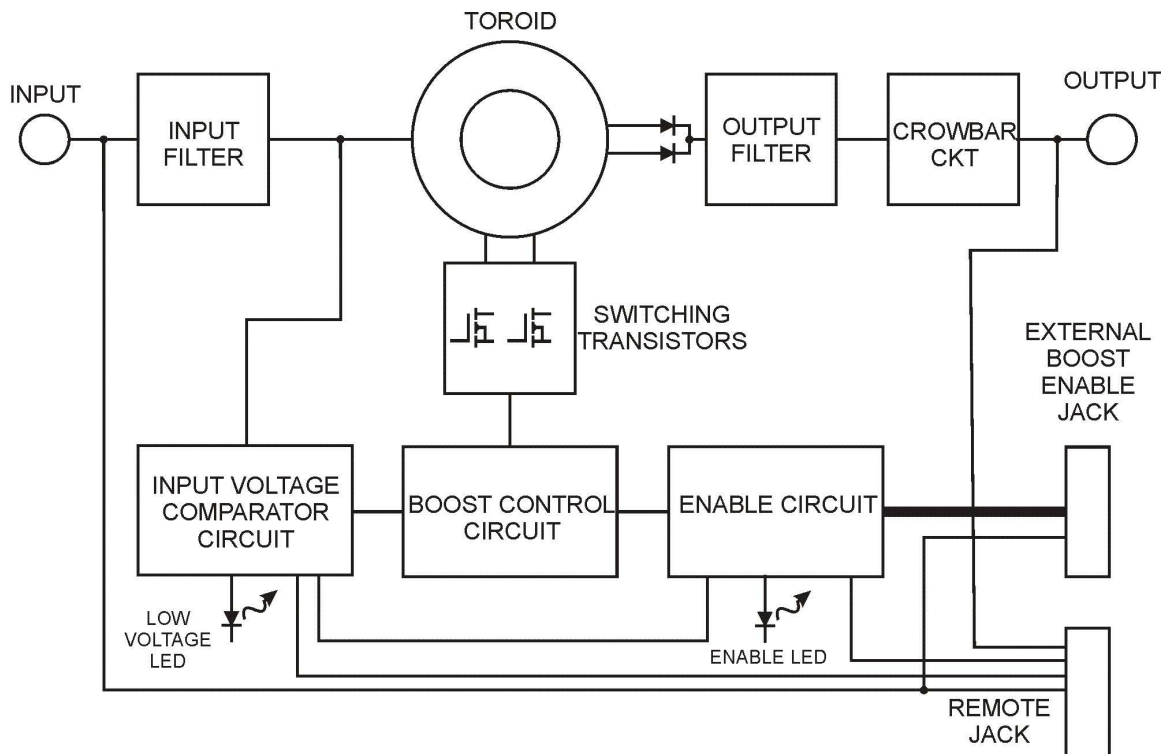


Figure 9 Block Diagram

**Input Filtering:** The input filter consists of C13 which provides EMI filtering followed by L1, C12 and C11 which are a low pass filter at the alternator which range. C8, C9 and C10 provide low ESR energy storage which helps to suppress input noise while providing energy during input low voltage transient periods. Diode D1 and capacitors C3 and C4 provide additional filtering and energy storage feeding the SMPS controller IC1. The additional energy storage is isolated from any transient load causing a voltage drop on the input protecting IC1 from resets and gaps in the boost function. Diode D2 is a transient suppressor diode and acts to protect the unit against transient voltages greater than 15 Volts.

**SMPS controller:** IC1 is a packaged SMPS controller with built in voltage reference. This is a constant frequency pulse width modulated regulator with built in driver for the MOSFET gates. The switching frequency is set as 50Khz. The controller is enabled/disabled by the soft start control input. This input is grounded to disable the SMPS boost supply. An open collector of Q8 and series resistor R44 provide the control function. Feedback from the output voltage is provided by the voltage divider consisting of R9, Potentiometer R8 and R10. This feedback is compared against the voltage reference to adjust the pulse width and resulting voltage output. The voltage reference is supplied to the analog control section for voltage level decision making.

**MOSFET drivers and transformer:** A push pull configuration using two FDP56N06 MOSFETs drives the transformer T1. T1 uses two tapped windings allowing the input voltage to be placed in series with the SMPS output voltage. The turns ration is .57:1 in series with the DC input voltage results in a boost of 1.57 over the input voltage. The tapped points on the two windings are fed to the common cathode rectifier pair D3. Using MOSFET Q1 as an example for both the Q1 and Q2 circuitry. The gate circuit consists of R6, R3 and FB1. R6 and FB1 minimize ringing and parasitic oscillations while R3 is a base drain that discharges the gate to substrate capacity while the unit is not powered. The storage of energy in the gate capacity as a result of residual energy from previous operation or static can allow both transistors to attempt to conduct during the next power up cycle before the control IC takes control of the gate usually destroying one or both MOSFETs.

**Output Filtering:** The output filter consists of toroid inductor L2 with capacitors C14 through C22 that act as a low pass filter and energy storage bank. The total energy storage is 23,500 UF distributed over 5 capacitors to minimize ESR. Capacitor C22 is located close to the output and serves as an EMI suppressor. Diode D4 is a 15 volt transient suppressor diode and protects the unit from transient seen on the output terminals.

**Over-voltage Protection:** SCR T2 provides a overvoltage crowbar which is controlled by zener diode D5. The input circuitry uses a pi filter consisting of C25, L3 and C24. This filter minimizes the false tripping of the OVP circuit by RF energy radiated back into the power leads. R12 protects the gate of the SCR against high currents and C23 and R11 provide time delay and protects against leakage currents through D5 tripping the OVP.

**Enable Circuitry:** The SMPS boost circuit is controlled by grounding its “Soft Start” input. This is done with an open collector transistor circuit Q8 and series resistor R44. When Q8 is saturated the soft start input is held at ground and the SMPS boost is inoperative. The circuitry of Q8 provides an OR gate that allows either the enable line or the low voltage disable line to independently shut off the SMPS boost circuit. The enable line is pulled up to the DC input voltage by R13 and maybe grounded by Q7, SW1 or through pin 3 of the external control connector. The green LED is illuminated by the grounding of the enable line.

**External Keying Inputs:** Four external signals may enable the SMPS boost. Two negative going signals are inputted through X1 pins 1 and 2. These signals are ORed by D6 and pulled up by R30. Q6 acts as an inverter to produce a positive going signal that saturates Q7 grounding the enable line. Two positive going signals are inputted through X1 pins 3 and 4. These signals are ORed by D8 and fed to Q7. These signals directly saturate Q7 grounding the enable line. Each input line has a low pass filter to protect the unit from RF conducted from the transmitter and EMI conducted back to the receiver. A 100 mA auto-reset fuse is used to feed DC input voltage to pin 5 for powering external accessories.

**Low Battery Voltage Enable:** When enabled by HDR5 a low voltage on the input terminals may automatically enable the SMPS boost circuitry. HDR4 selects the trigger voltage level as 10, 11 or 12 volts. The 5 volt reference voltage supplied from the SMPS controller IC is used as a voltage reference for the trigger circuit IC2C. R36 and the resistor selected by HDR4 form a voltage divider used to compare against the reference voltage to set to low voltage trigger limit. When the low limit is reached the output of IC2C goes low discharging C41 through D9 and R40. IC2D acts as a high input impedance comparator against the reference voltage and when C41 is discharged the output of IC2D goes to ground which through HDR5 enables Q6 and through Q7 grounds the enable line. When the input voltage rises above the low limit potentiometer R41, R40 and C41 provide an adjustable time delay holding the SMPS boost on. The delay is to allow current peaks during SSB and CW that pull that battery low and trigger the SMPS to be held allowing a continuous SMPS boost output to assure a constant voltage is provided to the transmitter.

**Low Voltage Lockout:** HDR1 sets the low voltage limit that the SMPS boost is allowed to operate. When the input voltage is below the low limit the SMPS boost is disabled by saturating Q8 grounding the soft start line on IC1. The low voltage lockout maybe transient during the period the input voltage is low or maybe latched requiring power to be removed to reset the latch. The latching of the low voltage lockout is selected by HDR2. HDR1 selects an input resistor that with R16 form a voltage divider that with IC2A compare the input voltage to the reference voltage from IC1. HDR1 allows the limit to be set at 9, 10 and 11 volts. R14 provides feedback that sets the hysteresis of the comparator. The output of IC1A is pulled up by R15 and fed to D7. D7 feeds a negative going signal to Q4 which saturates Q5 illuminating the red LED and if HDR3 is present sounding the audio alert. D7 feed R23 which along with C33, IC2B and R22 form a time delay to minimize false trips of the lockout by transient voltage drops. The output of IC2B is normally low and is pulled up by R21. When the low voltage lockout is triggered IC2B output goes high feeding the low voltage disable signal through D10 saturating Q8 and disabling the SMPS boost circuit. Q3 is also saturated and if HDR2 is in place grounds the input voltage divider latching the lockout until the input power is removed.

**Remote Control Input:** An 8 pin RJ45 jack is provided to allow connection to the remote control unit. Each signal pin is bypassed to ground by EMI suppression capacitors. The Low voltage signal and enable signals are accessed by this jack. Input and output voltages are also present and protected by 100 mA auto-reset fuses.

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## IN CASE OF DIFFICULTY

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### Low Voltage Disconnect trips under high demand conditions

This can be caused by 2 things. First ensure your battery is charged. A discharged battery will recover voltage under low current conditions, but once current is drawn it will immediately drop below the cutout voltage. Second, ensure the wiring on the input side of the unit is adequate for the current being drawn and the lengths of the cable run.

### Enable LED fails to illuminate.

Ensure that you are either feeding one of the enable lines from the radio amplifier key line into the unit or the Enable/Disable switch is depressed.

### Minimum Battery Voltage

According to battery manufacturers vehicle batteries are normally considered drained at 11.6V with no load. Under load the voltage will be a little lower. Below about 9-10V the voltage will drop fast with any load. The battery life may suffer and the vehicle may not start when the battery is that low.

[http://www.eetimes.com/author.asp?section\\_id=36&doc\\_id=1320644](http://www.eetimes.com/author.asp?section_id=36&doc_id=1320644)

## TECHNICAL ASSISTANCE

If you have any problem with this unit first check the appropriate section of this manual. If the manual does not reference your problem or is your problem is not solved by reading the manual, you may call MFJ Technical Service at 662-323-0549 or the MFJ Factory at 662-323-5869. You will be best helped if you have your unit, manual and all information on your station handy so you can answer any questions the technician may ask.

You can also send questions by mail to:

MFJ Enterprises, Inc.  
300 Industrial Park Road  
Starkville, MS 39759

by Facsimile (FAX) to 662-323-6551

or by email to [techinfo@mfjenterprises.com](mailto:techinfo@mfjenterprises.com).

Send a complete description of your problem, an explanation of exactly how you are using your unit, and a complete description of your station.

### Available Accessories:

MFJ-4416BRC Remote Control  
MFJ-5262 CAT5E cable

### Radio Power Cables:

MFJ-5112, MFJ-5112M Yaesu, Kenwood, Icom VHF/UHF  
MFJ-5535, MFJ-5535M Yaesu, Kenwood, Icom HF  
MFJ-5538, MFJ-5538M Yaesu 4 pin HF



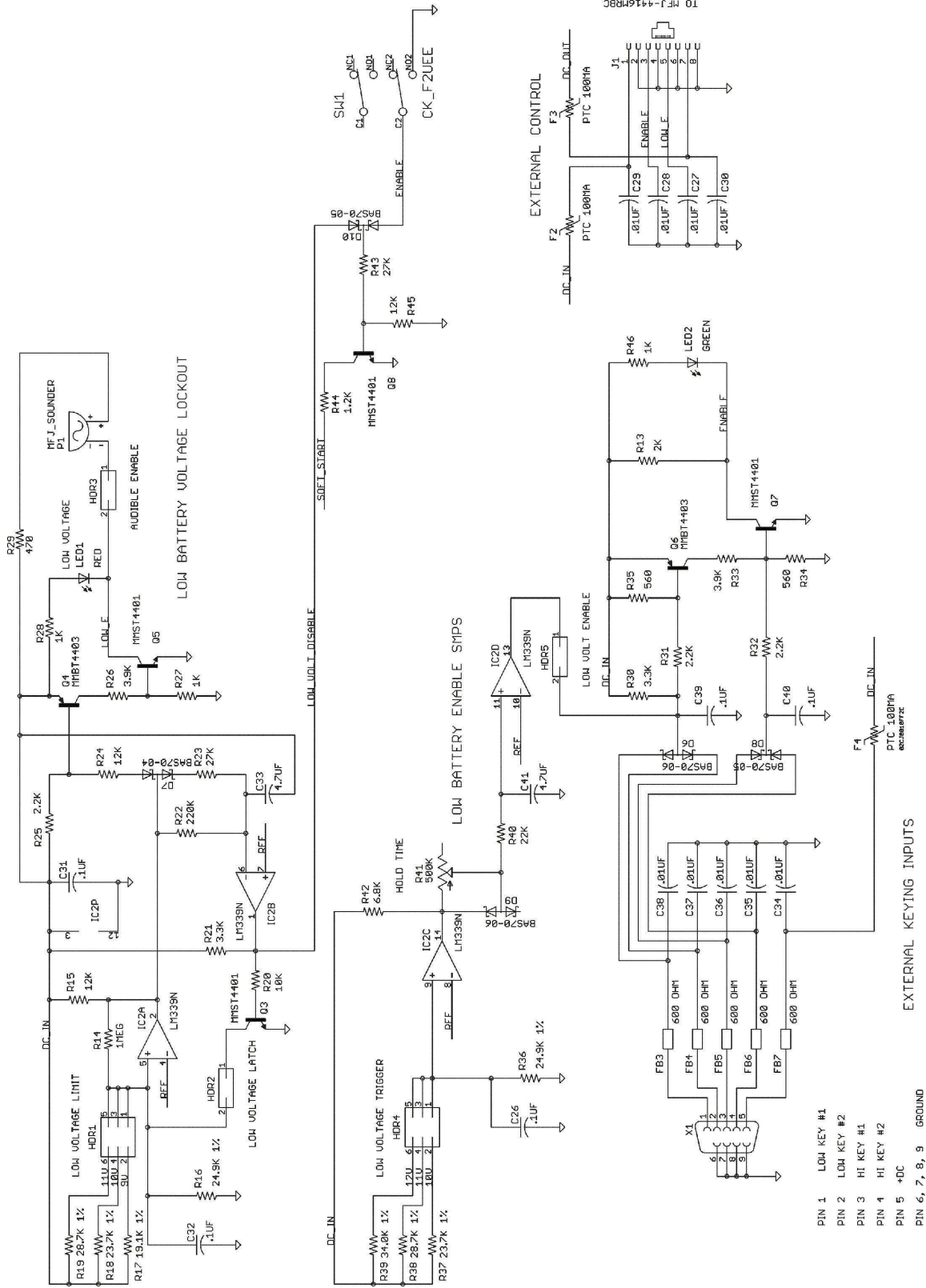


Figure 11 Control Section Schematic

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## FULL 12-MONTH WARRANTY

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MFJ Enterprises, Inc. warrants to the original owner of this product, if manufactured by MFJ Enterprises, Inc. and purchased from an authorized dealer or directly from MFJ Enterprises, Inc. to be free from defects in material and workmanship for a period of 12 months from date of purchase provided the following terms of this warranty are satisfied.

1. The purchaser must retain the dated proof-of-purchase (bill of sale, canceled check, credit card or money order receipt, etc.) describing the product to establish the validity of the warranty claim and submit the original or machine reproduction of such proof of purchase to MFJ Enterprises, Inc. at the time of warranty service. MFJ Enterprises, Inc. shall have the discretion to deny warranty without dated proof-of-purchase. Any evidence of alteration, erasure, or forgery shall be cause to void any and all warranty terms immediately.
2. MFJ Enterprises, Inc. agrees to repair or replace at MFJ's option without charge to the original owner any defective product provided the product is returned postage prepaid to MFJ Enterprises, Inc. with a personal check, cashiers check, or money order for **\$12.00** covering postage and handling.
3. MFJ Enterprises, Inc. will supply replacement parts free of charge for any MFJ product under warranty upon request. A dated proof of purchase and a **\$8.00** personal check, cashiers check, or money order must be provided to cover postage and handling.
4. This warranty is **NOT** void for owners who attempt to repair defective units. Technical consultation is available by calling (662) 323-5869.
5. This warranty does not apply to kits sold by or manufactured by MFJ Enterprises, Inc.
6. Wired and tested PC board products are covered by this warranty provided **only the wired and tested PC board product is returned**. Wired and tested PC boards installed in the owner's cabinet or connected to switches, jacks, or cables, etc. sent to MFJ Enterprises, Inc. will be returned at the owner's expense un-repaired.
7. Under no circumstances is MFJ Enterprises, Inc. liable for consequential damages to person or property by the use of any MFJ products.
8. **Out-of-Warranty Service:** MFJ Enterprises, Inc. will repair any out-of-warranty product provided the unit is shipped prepaid. All repaired units will be shipped COD to the owner. Repair charges will be added to the COD fee unless other arrangements are made.
9. This warranty is given in lieu of any other warranty expressed or implied.
10. MFJ Enterprises, Inc. reserves the right to make changes or improvements in design or manufacture without incurring any obligation to install such changes upon any of the products previously manufactured.
11. All MFJ products to be serviced in-warranty or out-of-warranty should be addressed to **MFJ Enterprises, Inc., 300 Industrial Park Rd, Starkville, Mississippi 39759, USA** and must be accompanied by a letter describing the problem in detail along with a copy of your dated proof-of-purchase and a telephone number.
12. This warranty gives you specific rights, and you may also have other rights, which vary from state to state.