

MATCH PRO CPM-1000  
2/7/02

# **MATCH PRO CPM-1000**

## **AUTOMATIC MATCHING NETWORK**

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FP2213Rx	MATCH PRO CPM-1000 Block Diagram
FP2213Rx	MATCH PRO CPM-1000 Mechanical Control Drawing
FA0114Rx	MATCH PRO CPM-1000 Phase/Magnitude/Forward Detector
FA0727Rx	MATCH PRO Motor Servo Assembly
FA0718Rx	MATCH PRO CPM-1000 Remote
FA0718Rx	MATCH PRO CPM-1000 Remote Mechanical Control Drawing
FA0704Rx	MATCH PRO Control/Interface Assembly
FA0306Rx	+/-15VDC Supply

**NOTE: Before installing equipment, carefully read and familiarize yourself with the entire operations manual. Observe and obey all WARNING and CAUTION notes provided.**

## I. Introduction

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This document describes and contains the necessary information for the installation, operation, troubleshooting and maintenance of the Comdel Model MATCH PRO CPM-1000 automatic matching network, hereinafter referred to as the MATCH PRO.

## II. Safety Information

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### Warning Label and Safety Marking Explanations:

The following symbols and terms may be found on an instrument or used in this manual.



This label indicates a general warning or caution condition.



This symbol indicates the presence of high voltages in or around the unit.



This symbol indicates the presence of RF energy in or around the unit.



This label indicates a presence of high voltage in or around the equipment, which may cause severe injury or death. All appropriate precautions should be observed when installing, operating or servicing this equipment.



This label indicates the presence of Radio Frequency energy in and around the equipment, which may cause burns or other injuries. All appropriate precautions should be followed when installing, operating or servicing this equipment.

### Terms in This Manual:

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. **Always read the associated information** very carefully before performing the indicated procedure.

The **CAUTION** statements identify conditions or practices that could result in damage to the equipment or other property.

### **QUALIFIED SERVICE TECHNICIAN, QUALIFIED ELECTRICIAN, QUALIFIED PERSONNEL –**

These terms indicate persons specifically trained to install, service or otherwise handle electronic equipment of the character and hazard potential of this unit.

## Terms as Market on Equipment:

**DANGER** indicates a personal injury hazard immediately accessible as one reads the marking.

**CAUTION** indicates a personal injury hazard not immediately accessible as one reads the markings, or a hazard to property, including the equipment itself.

## **Read And Understand This Section Fully Before Installing or Operating This Equipment.**

**WARNING: This equipment must be installed, operated and serviced only by trained, qualified persons.**

**CAUTION: There are no user or operator serviceable parts inside this equipment. Refer all service to a qualified service technician.**

### Line Power Source

- This product is intended to operate from a power source that does not apply more than 130 volts RMS between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

### General Safety Precautions



- **WARNING:** This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.



- **WARNING:** Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render and electric shock.
- Use only the power cord and connector specified for your product. To avoid hazard, use only a fuse of the correct type and current rating as specified on the rear panel of your product.



- **WARNING:** To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

### Servicing Safety Instructions



- **WARNING:** Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections or components while power is on.
- Disconnect power before removing protective panels, soldering, or replacing components.

### Power Source

This product is intended to operate from a power source that does not apply more than 130 volts RMS between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the ground conductor in the power cord is essential for sage operation.

### III. Description

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The MATCH PRO is a fully automatic tuning system, which matches the impedance of most plasma chambers to a 50 ohm transmission line. It is capable of handling up to 1000 watts CW. Models are available for operation at frequencies from 2 to 45 MHz.

The MATCH PRO is built in a modular construction and is comprised of two units: the tuning unit and the control unit. Subassemblies can easily be removed for servicing or replacement. The tuning unit contains the matching components, (variable capacitors and inductor), two DC motor servos, and RF sensors to provide feedback to the DC motor servos. The control unit utilizes the RF feedback signals from the tuning unit to control the DC motor servos. The control unit also provides controls for manual and remote operation of the tuning unit.

The MATCH PRO is intended for use in plasma systems. Mounting position and location is at the discretion of the user, however the MATCH PRO output should be located as close as possible to the plasma chamber.

#### Reference Data

MATCH PRO tuning unit	12" x 8" x 5"
MATCH PRO control unit	3.5"H x 7.5"W x 6.125"D half rack
Frequency Range	2 - 45 MHz
RF Power Capability	Typical 1KW max (Model CPM 1000)
VSWR	Less than 1.5 to 1 when tuned referenced to 50 ohms
Tune Power	25 W minimum
Power Consumption	10 W Nom - 25 W when tuning
Ambient Temperature Operation	-10 to +40° C

### IV. Installation

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#### A. Unpacking and Inspection

No special procedure is required for unpacking the MATCH PRO. Common sense and normal care should be taken to avoid damage to connectors, switches and indicators. Each item should be examined carefully for any obvious physical damage. Save the packing material and containers to substantiate any claim to the transportation agency should any damage be found. The following items should be found in the shipping container:

1. MATCH PRO CPM-1000 tuning unit.
2. MATCH PRO CPM-1000 control unit.
3. Ten foot control interconnect cable.
4. AC power line cord.
5. Operating manual.

#### B. Mounting

The MATCH PRO tuning unit may be rack mounted (extra cost option) in a standard 19" relay rack or hard mounted in any orientation by means of the six mounting holes located in one 12" x 8" side or six mounting holes located in on 12" x 5" side. If the unit is rack mounted, additional support should be provided to support the cantilevered section.

### C. Primary Power

The MATCH PRO requires 115 V, 50/60 Hz, 1 Phase, 1A.

### D. Cooling

The CPM 1000 tuning unit uses no fans for cooling. However, air space around the unit, especially around the vent holes, should be left unencumbered to facilitate convection cooling. For applications of high current where additional cooling is required, mounting holes are provided on the large surfaces for a 5" fan.

### E. Inspection and Adjustment

Before the equipment is installed or energized, a thorough inspection should be conducted to insure that the MATCH PRO is electrically and mechanically ready for operation. The following points should be checked. Re- placement or repairs should be made as necessary.



**WARNING:** Under certain operating conditions the voltages existing in the RF tuning elements within the MATCH PRO may be hazardous.

1. Ensure that all mounting hardware has been properly installed and tightened.
2. Ensure that internal and external cables are connected properly and completely seated and tightened.
3. Ensure that unit enclosure, when installed, is properly grounded to main frame of equipment.

The MATCH PRO is shipped fully adjusted. No further alignment or adjustment is required. If, during operation, miss adjustment is suspected refer to Section V and perform the required procedure.

## V. Theory of Operation

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The MATCH PRO network automatically tunes the impedance of the plasma chamber to the 50 ohm transmission line from the power generator. Furthermore it constantly monitors the input impedance to assure that is always 50 ohms regardless of changes in plasma characteristics during process.

### A. Controls and Indicators

#### Control Unit:

- |                          |   |
|--------------------------|---|
| 1. Power On LED          | Indicates the presence of line power into the control circuitry of the MATCH PRO.   |
| 2. Power On/Off Switch   | Controls line power input   |
| 3. AUTO/MAN switches     | Connects DC motor servo to either RF sensor for automatic operation or SERIES/SHUNT pots for manual control of DC motor servos. |
| 4. SERIES/SHUNT SET pots | Adjusts position of tuning capacitor when in manual mode.   |
| 5. REMOTE/LOCAL switch   | Switches manual operation between remote 0-10V inputs or manual control SET pots.   |
| 6. AUTO HOME switch      | When ON, operation is automatically switched between manual mode when RF is off and automatic mode when RF                      |

is on. When OFF, operation of DC motor servos are determined by AUTO/MAN switches. Putting an AUTO/MAN switch in MANUAL overrides operation of AUTO/HOME switch (always in MANUAL mode). Normal operation using AUTO/HOME to provide a preset starting position requires both AUTO/MAN switches in the AUTO position.

- 7. RF ON LED This lamp indicates RF has been detected in the tuning unit.
- 8. DIGITAL DISPLAY METER Indicates value of parameter as selected by METER SELECTION SWITCH.

9. METER SELECTION SWITCH

PHASE: Indicates relative output of phase RF sensor output.

MAG: Indicates relative output of magnitude RF sensor output.

SER POS: Indicates percentage of mesh of the series tuning capacitor.

SER SET: Indicates setpoint position, (remote, local, or auto), for the series tuning capacitor as sent to the DC motor servo.

SHUNT SET: Indicates setpoint position, (remote, local, or auto), for the shunt tuning capacitor as sent to the DC motor servo.

SHUNT POS: Indicates percentage of mesh of the shunt tuning capacitor.

### ***Tuning Unit***

- 1. MAGNITUDE/PHASE pots Factory set RF sensor calibration pots. Phase pot controls series capacitor and Magnitude pot controls shunt cap.

2. Control Unit Remote I/O Connector - J1

Pin 4: Series cap position output, 0-10V = 0-100%

Pin 7: Shunt cap position output, 0-10V = 0-100%

Pin 8: Shunt cap setpoint input, 0-10V = 0-100%

Pin 11: I/O Return

Pin 12: I/O Return

Pin 17: Disable in, pull low to disable tuning unit

Pin 18: Series cap setpoint input, 0-10V = 0-100%

Pin 21: I/O Return

Pin 22: DC bias output (optional)

Pin 23: I/O Return

Pin 24: I/O Return

Pin 1,2,3,5,6,9,10,13,14,15,16,19,20,25: Not Used

**NOTE:** See Dwg. # FA0704Rx and FA0718Rx

## **B. Operating Instructions**

1. Preliminary Procedures
  - 1.1 With MATCH PRO mounted in system, install RF output and output connections and the AC power cable
  - 1.2 Turn on the Power On/Off switch
  - 1.3 Set SERIES and SHUNT control switches to MANUAL
  - 1.4 Exercise SERIES and SHUNT caps by alternately rotating the position pots and verifying proper capacitor motion by observing that the POSITIONS track SETPOINTS.
2. Normal Sequence of Operation
  - 2.1 Automatic tuning

Normally no controls are required for the automatic operation of the MATCH PRO. In automatic mode, all adjustments to the tuning elements are made by commands from the PHASE/MAG/FORWARD SENSOR (FA0114Rx) via the interconnect cable. The SERIES and SHUNT AUTO/MAN switches should be in the AUTO position. The DIGITAL DISPLAY METER may be used to observe the status of the tuning unit.
  - 2.2 Manual tuning

Manual tuning may be required if load conditions are such that matching network cannot achieve a 1.5 to 1 VSWR. To tune manually one must be able to visually monitor reflected power (i.e. reflected power meter on the Comdel CPS-1000 RF Power Source). The SERIES and SHUNT AUTO/MAN switches should be in the MANUAL position and the REMOTE/LOCAL switch should be in the LOCAL position. Alternatively rotate the SERIES and SHUNT position pots to achieve the lowest reflected power reading possible.
  - 2.3 Remote tuning applications using J1 connector

If required the MATCH PRO can be connected to operate remotely. When used in remote the REMOTE/LOCAL switch should be set to REMOTE. All MANUAL mode positioning will then be done from a remote location based upon 0 to 10 Volt analog inputs. (See Section V.B., parts 2.1 and 2.2 for normal sequence of operation.)

## **VI. Alignment Procedures**

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The MATCH PRO is aligned at Comdel. If for any reason the unit needs to be realigned, follow these procedures. Alignment should be performed by qualified personnel only.



**WARNING:** There are hazardous voltages inside enclosure.

1. Turn RF and POWER OFF off.
2. Remove 1/4" hole plugs labeled PHASE and MAG located on the side of the tuning unit.



3. Nulling RF SENSOR (PHASE/MAG/FWD) board:
  - 3.1 Connect MATCH PRO to the remote and an appropriate load. Connect the generator to the RF Input connection.
  - 3.2 Apply RF to MATCH PRO and follow manual tuning procedure. (See Section V.B., part 2.2)
  - 3.3 Put METER SELECTION SWITCH in the PHASE position. Adjust PHASE trimmer pot on side of tuning unit until the meter registers 0.0.
  - 3.4 Put METER SELECTION SWITCH in the MAG position. Adjust MAG trimmer pot on side of tuning unit until the meter registers 0.0.

## VII. Troubleshooting

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**WARNING:** ONLY qualified personnel should perform troubleshooting. There are hazardous voltages inside the enclosure.

1. No PWR ON LED. Check 1 amp fuse at rear panel.
2. Unable to null power monitor board.
  - 2.1 Replace board (Comdel P/N FA0114Rx) and re-null.
3. Capacitor does not turn.
  - 3.1 Examine capacitor for mechanical failure. Loosen motor mount to disengage motor gear from capacitor and hand turn. If damaged, replace capacitor. If capacitor is not damaged, go to Step 3.2.
  - 3.2 Apply an external voltage of +/- 12 VDC across the motor. The current should be less than 300 mA. If motor does not turn or current is greater than 300 mA, replace motor. If no problem is found, go to Step 3.3.
  - 3.3 Turn on MATCH PRO power. Put the REMOTE/LOCAL switch in LOCAL and SERIES & SHUNT switches in MANUAL. The large 5 pin connector on each DC MOTOR SERVO PCB of the tuning unit should have the following voltages:

Pin 1, -12V  
Pin 3, +12V  
Pin 5, +12V  
All voltages are with respect to enclosure ground

If all voltages are present check Pin 3 of small 5 pin connector on each DC MOTOR SERVO PCB of the tuning unit. Pin 3 voltage should track the position of the MANUAL control SETPOINT pot of the control unit. If SETPOINT voltages not present and interconnect cable check OK, Replace MATCHPRO I/O INTERFACE PCB, Comdel P/N FA0704Rx.

If there are some or all of the power supply voltages (+/-12 & +12) missing check interconnect cable. If cable OK (all pins connect to all pins), replace DC MOTOR SERVO PCB Comdel P/N FA0727Rx.
  - 3.4 If the above steps fail to remedy the problem encountered, call the factory at 800-468-3144 for a return material authorization number or technical assistance.

## VIII. Maintenance

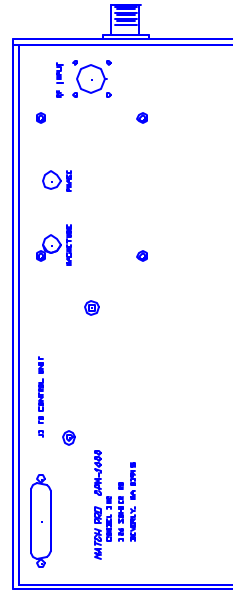
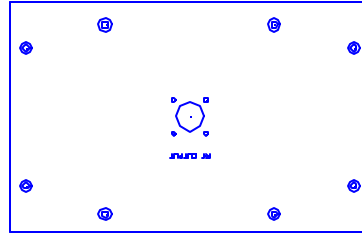
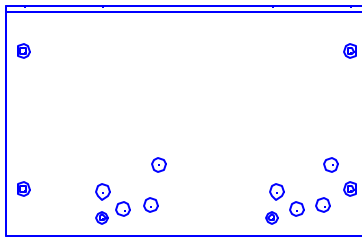
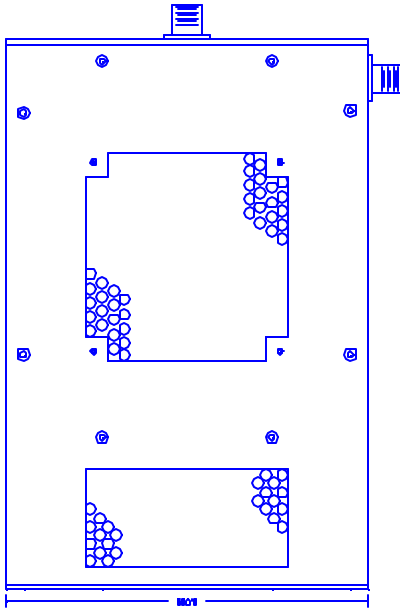
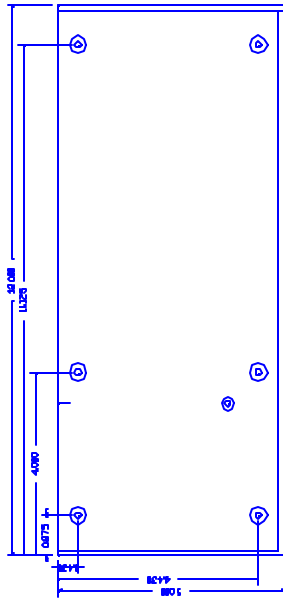
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An annual maintenance inspection should be performed on the auto-match.



**WARNING:** Maintenance should be performed by qualified personnel only. There are hazardous voltages inside the enclosure.

1. Remove the AC line and the top cover.
2. Inspect all components for loose screws and nuts (especially around the tuning capacitor).
3. Inspect capacitor plates and make sure that they are equally spaced apart and free of all debris.
4. While cover is off, check and see if capacitors spin smoothly. To do this follow the procedures for manual control and adjust SERIES and SHUNT positions across their full range.
5. Check the mesh of the gears between motor and capacitor and between capacitor and feedback pots. If there is any play in the mesh adjust motor or feedback pot mounting bracket as required to eliminate backlash play.



NO.	DESCRIPTION	QTY	UNIT
1	CONTROL PANEL	1	PCB
2	CONTROL PANEL	1	PCB
3	CONTROL PANEL	1	PCB
4	CONTROL PANEL	1	PCB
5	CONTROL PANEL	1	PCB
6	CONTROL PANEL	1	PCB
7	CONTROL PANEL	1	PCB
8	CONTROL PANEL	1	PCB
9	CONTROL PANEL	1	PCB
10	CONTROL PANEL	1	PCB
11	CONTROL PANEL	1	PCB
12	CONTROL PANEL	1	PCB
13	CONTROL PANEL	1	PCB
14	CONTROL PANEL	1	PCB
15	CONTROL PANEL	1	PCB
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