METCAL MX-500P-11 TECHNICAL DOCUMENTATION

This documentation was carefully reverse engineered from several actual MX-500P units, and although it has been meticulously triple checked, it may contain errors and omissions so use it at your own risk. It is provided solely for the purpose of helping you satisfy your personal curiosity about how a Metcal MX-500P works, and you must never use it for any other purpose, especially not for any commercial or business purpose, and certainly not as an aide to experimenting with or performing work on MX-500P units, as it is inadequate for such unintended use. Reproduction is strictly forbidden.

MECHANICAL DESCRIPTION:

The small plastic cover at the two RF output connectors is held in place by it's two plastic hooked clips which descend into the aluminum housing at the top and bottom. Beneath this plastic cover are two hex nuts that bolt the RF connectors to the aluminum housing. The RF connectors are soldered directly into the circuit board. On the rear of the MX-500P are four deeply recessed T15 tamper proof Torx screws which hold the two halves of the aluminum casting together. Loosening the single screw in the upper-middle back of the MX-500P by a few turns releases the internal heat sink which is attached to the circuit board. The internal heat sink couples heat into the MX-500P aluminum case from where it can dissipate into the ambient air. Good thermal coupling between the internal heat sink and the case is aided by a thin coating of white thermal compound. The circuit board inside the MX-500P is fastened down by six internal screws, four of which are rather large because they also hold down the line transformer. The tiny grub screw on the upper right hand side of the MX500 controls the Auto Sleep feature and should not be tightened past the point where it gently activates the switch. Note that it can be dangerous to power up an MX-500P unit that has been taken apart or that has been reassembled by anyone other than an trained Metcal service technician.

DESCRIPTION OF FUNCTION:

The MX-500P Power Unit provides RF energy at 13.560MHz to the Soldering Tip Cartridge, which contains an induction heater consisting of an 18 turn AWG33 wire coil wound around a 0.11" diameter by 0.5" long slug. The slug is composed of a copper core, clad in a thin magnetic alloy having a curie point equal to the desired soldering tip temperature. The magnetic alloy absorbs RF energy from the coil, causing the slug to heat up until the curie temperature is reached. At this point absorption stops and heating ceases, because the RF energy is now reflected back to the power unit by the copper core.

The On/Off switch atop the power unit controls the 18V power supply U8, which runs all the supervisory circuits. When the 18V supply is off, Q6 turns off thereby causing Q7 to turn on and disable the RF generator.

Q5 and Q8 control a small DC bias voltage out to the soldering hand piece, so that U2a can sense an intermittent or disconnected hand piece cable, in which case the yellow LED DS2 will light and U2b will latch Q7 on, thereby disabling the RF generator until the On/Off switch is cycled.

U5a senses small changes in RF generator output power to the soldering hand piece. If no changes are detected for half an hour then sleep mode timer U6 times out causing U7 to latch Q11 on, thereby disabling the RF generator until the On/Off switch is cycled. This functionality can be disabled by backing out the tiny grub screw in the upper right side of the unit.

If thermal switch TS1 detects an over temperature condition inside the power unit then Q9 will turn on and disable the RF generator until the temperature drops back down to normal.

If Forward Power at T3 and C33 exceeds reasonable limits due to a fault in the power unit circuitry, then Q19 will turn on and disable the RF generator until Forward Power returns to acceptable levels.

U5b monitors the supervisory circuits and lights green LED DS1 if everything is OK, in which case Q12 will be on, enabling U4 to power up the RF generator.

U1 provides a 13.560MHz square wave out to class C driver stage Q3, which in turn drives the class C final output stage Q4, providing RF power to the soldering hand piece. Note that Q3 is unusual in that it has an input capacitance of only 55pF and a gate threshold voltage of only 1.6V.

Diodes D8 and D9 sense the RF voltage level coming out of the RF generator, providing negative feedback to switching power supply U4 Q1 Q2, which powers the final RF output stage Q4 of the RF generator.

J1 provides a DC voltage which is proportional to the power being delivered to the hand piece. It can be connected to an analog meter movement or other measuring instrument.

TRIMPOT DESCRIPTIONS:

RV2 adjusts the RF-Output-Power delivered to the hand piece; if this adjustment is incorrect then the voltage at C8 will likely not correspond to the values given elsewhere in this document.

RV1 sets the Forward-Power-Fault safety shutdown circuit trip point; if this adjustment is incorrect then the voltage at C16 will likely not correspond to the values given elsewhere in this document.

RV3 calibrates the signal out to any Meter connected at J4; the signal at J4 is not normally used so it is hard to imagine how this adjustment could have any impact upon the operation of the unit.

Calibration is well beyond the scope of this document and must not be attempted by anyone other than a qualified Metcal service technician.

MEASUREMENTS FROM SOME GOOD WORKING UNITS:

Whenever unit is plugged into the AC line:
- Voltage at C2 will measure approximately 26 VDC
- Voltage at C6 will measure approximately 53 VDC

Whenever the power switch is on and unit is plugged in:
- U8 pin 3 will measure 18 VDC
- U7 pin 14 will measure 12 VDC

Whenever a hand piece is connected and the green LED is lit:
- U4 pin 4 will measure 1.3 VDC
- U4 pin 5 will measure 0.0 VDC

If the green LED is extinguished but the unit is plugged in:
- U4 pin 5 will measure 26 VDC

Whenever the hand piece is idling hot in the stand:
- Voltage at C8 will measure between 17 and 18 VDC
- Voltage at C3 will measure between 14 and 15 VDC
- Voltage at C16 will measure approximately minus 1.2 VDC
- U1 pin 14 will measure approximately 4.8 VDC
- U1 pin 4 will have a 13.56 Mhz waveform approximately 2.8 Vpp

When the soldering hand piece is heating up from a cold start:
- Voltage at C8 may temporarily rise as high as 21 VDC
- Voltage at C16 may temporarily rise as high as minus 0.22 VDC

When the hot hand piece is touched to something cold:
- U5 Pin 1 will pulse high momentarily

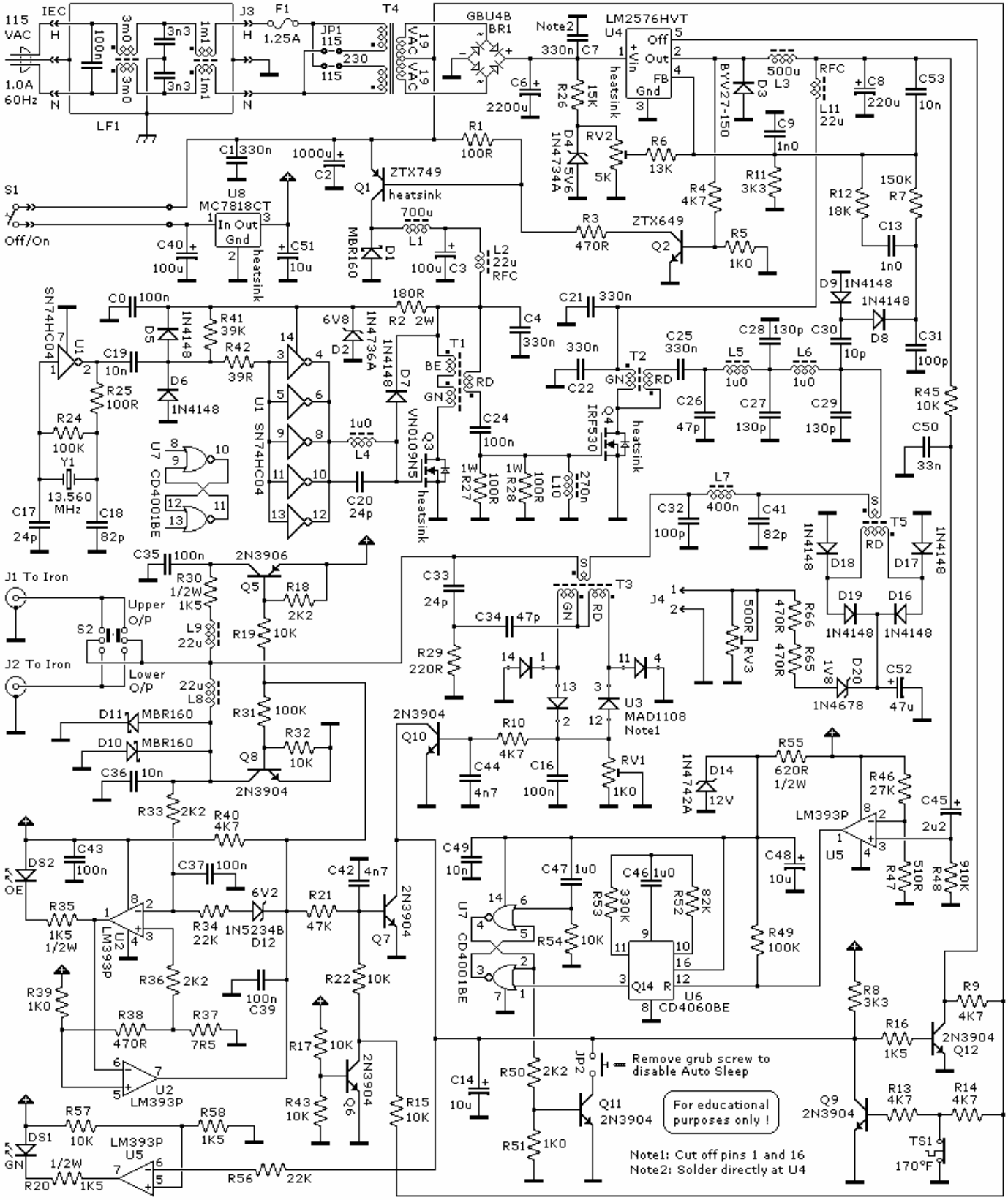
Characteristics of a cold MX Soldering Tip Cartridge:
- Inductance at 1kHz is somewhere around 2.8 uH
- DC resistance is fairly close to 0.21 ohms

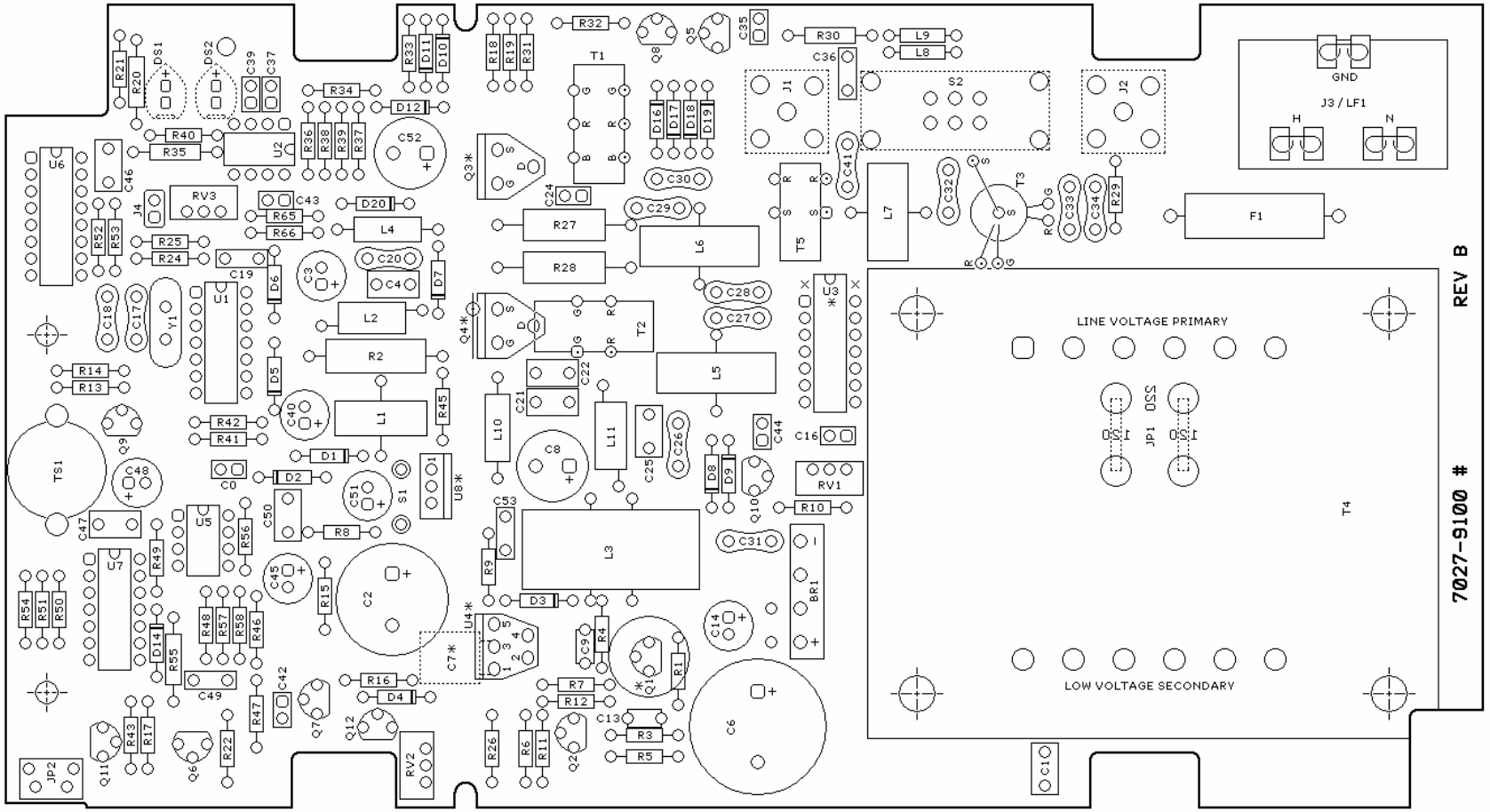
ADDITIONAL INFORMATION:

For specifications and descriptions of operator controls and lights, please consult you Metcal Users Manual and the 1999 Metcal product catalog which can be found on the Internet via Google as of this writing.

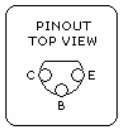
US Patent Number 4626767 contains a wealth of additional technical information. US Patents are available for free on the Internet from various sources such as http://www.freepatentsonline.com/

MX-500P-11 SCHEMATIC DIAGRAM





MX-500P-11 CIRCUIT BOARD
PARTS PLACEMENT DIAGRAM



For educational purposes only !

NOTES:
*SOLDER C7 DIRECTLY TO U4 PINS 1 & 3 ON REAR OF PCB
*MAKE U3 INTO A 14 PIN IC BY CUTING OFF PINS 1 & 16
*SEMICONDUCTORS Q3 Q4 U4 U8 & Q1 HAVE HEATSINKS
*Q4 IS DOUBLE SHIELDED & INSULATED FROM HEATSINK
*Q3 IS INSULATED FROM HEATSINK

MX-500P-11 CIRCUIT BOARD PARTS LIST

BR1	Bridge Rectifier 4A 100V (GBU4B)
C0	100nF 63V 5% Polyester (WIMA MKS02 PCM2.5)
C1	330nF 63V 5% Polyester (WIMA MKS2 PCM5)
C2	1000uF 35V Aluminum Electrolytic
C3	100uF 35V Aluminum Electrolytic
C4	330nF 63V 5% Polyester (WIMA MKS2 PCM5)
C6	2200uF 50V Aluminum Electrolytic
C7*	330nF 63V 5% Polyester (WIMA MKS2 PCM5)
C8	220uF 63V Aluminum Electrolytic
C9	1n0F 200V 10% Ceramic (CK05BX102K 200V)
C13	1n0F 200V 10% Ceramic (CK05BX102K 200V)
C14	10uF 35V Aluminum Electrolytic
C16	100nF 63V 5% Polyester (WIMA MKS02 PCM2.5)
C17	24pF 500V 5% SilverMica (CM05ED240J03)
C18	82pF 500V 5% SilverMica (CM05ED820J03)
C19	10nF 200V 10% Ceramic (CK06BX103K 200V)
C20	24pF 500V 5% SilverMica (CM05ED240J03)
C21	330nF 63V 5% Polyester (WIMA MKS2 PCM5)
C22	330nF 63V 5% Polyester (WIMA MKS2 PCM5)
C24	100nF 63V 5% Polyester (WIMA MKS02 PCM2.5)
C25	330nF 63V 5% Polyester (WIMA MKS2 PCM5)
C26	47pF 500V 5% SilverMica (CM05ED470J03)
C27	130pF 500V 5% SilverMica (CM05ED131J03)
C28	130pF 500V 5% SilverMica (CM05ED131J03)
C29	130pF 500V 5% SilverMica (CM05ED131J03)
C30	10pF 500V 5% SilverMica (CM05ED100J03)
C31	100pF 500V 5% SilverMica (CM05ED101J03)
C32	100pF 500V 5% SilverMica (CM05ED101J03)
C33	24pF 500V 5% SilverMica (CM05ED240J03)
C34	47pF 500V 5% SilverMica (CM05ED470J03)
C35	100nF 63V 5% Polyester (WIMA MKS02 PCM2.5)
C36	10nF 200V 10% Ceramic (CK06BX103K 200V)
C37	100nF 63V 5% Polyester (WIMA MKS02 PCM2.5)
C39	100nF 63V 5% Polyester (WIMA MKS02 PCM2.5)
C40	100uF 35V Aluminum Electrolytic
C41	82pF 500V 5% SilverMica (CM05ED820J03)
C42	4n7F 63V 5% Polyester (WIMA MKS02 PCM2.5)
C43	100nF 63V 5% Polyester (WIMA MKS02 PCM2.5)
C44	4n7 63V 5% Polyester (WIMA MKS02 PCM2.5)
C45	2u2F 50V Dipped Tantalum
C46	1u0F 63V 5% Polyester (WIMA MKS2 PCM5)
C47	1u0F 63V 5% Polyester (WIMA MKS2 PCM5)
C48	10uF 35V Aluminum Electrolytic
C49	10nF 200V 10% Ceramic (CK06BX103K 200V)
C50	33nF 63V 5% Polyester (WIMA MKS2 PCM5)
C51	10uF 35V Aluminum Electrolytic
C52	47uF 63V Aluminum Electrolytic
C53	10nF 200V 10% Ceramic (CK06BX103K 200V)
D1	Schottky Rectifier 1A 60V (MBR160 or SR160)
D2	Zener Diode 6.8V 1W (1N4736A)
D3	Fast Avalanche Rectifier 2A 150V (BYV27-150)
D4	Zener Diode 5.6V 1W (1N4734A)
D5	Small Signal Silicon Diode (1N4148)
D6	Small Signal Silicon Diode (1N4148)
D7	Small Signal Silicon Diode (1N4148)
D8	Small Signal Silicon Diode (1N4148)
D9	Small Signal Silicon Diode (1N4148)
D10	Schottky Rectifier 1A 60V (MBR160 or SR160)
D11	Schottky Rectifier 1A 60V (MBR160 or SR160)
D12	Zener Diode 6.2V 500mW (1N5234B)
D14	Zener Diode 12V 1W (1N4742A)
D16	Small Signal Silicon Diode (1N4148)
D17	Small Signal Silicon Diode (1N4148)
D18	Small Signal Silicon Diode (1N4148)
D19	Small Signal Silicon Diode (1N4148)
D20	Zener Diode 1.8V 500mW (1N4678)
DS1	Green Rectangular LED 2x5mm
DS2	Orange Rectangular LED 2x5mm
F1	Time Delay Fuse 1.25A/250V (LittleFuse 239)
J1	PCB Mounted Connector Female Type F
J2	PCB Mounted Connector Female Type F
J3	PCB Mounted Female Quick-Connects
J4	Unshrouded Header Two Pin 0.1 Inch Pitch
JP1	Line Voltage Selection Strapping on PCB
JP2	Miniature PCB Mount Pushbutton Switch
L1	700uH Toroidal Inductor Many Turns
L2	22uH RF Choke 6-Port Bead
L3	500uH Toroidal Inductor 94.75 Turns
L4	1u0H Inductor DRWW
L5	1u0H Toroidal Inductor 16.75 Turns
L6	1u0H Toroidal Inductor 16.75 Turns
L7	400nH Toroidal Inductor 10.75 Turns
L8	22uH Inductor DRWW
L9	22uH Inductor DRWW
L10	270nH Inductor DRWW
L11	22uH RF Choke 6-Port Bead
LF1	Two Stage Line Filter (Delta 03SEEG3H)
Q1*	PNP 1 Watt Transistor (ZTX749)
Q2	NPN 1 Watt Transistor (ZTX649)
Q3*	N-Channel Power MOSFET (VN0109N5)
Q4*	N-Channel Power MOSFET (IRF530)
Q5	PNP Small Signal Transistor (2N3906)
Q6	NPN Small Signal Transistor (2N3904)
Q7	NPN Small Signal Transistor (2N3904)
Q8	NPN Small Signal Transistor (2N3904)
Q9	NPN Small Signal Transistor (2N3904)
Q10	NPN Small Signal Transistor (2N3904)
Q11	NPN Small Signal Transistor (2N3904)
Q12	NPN Small Signal Transistor (2N3904)

Continuation and notes on next page...

MX-500P-11 CIRCUIT BOARD PARTS LIST

R1	100R 1/4W 5% Carbon Film
R2	180R 2W 5% Carbon Film or Metal Film
R3	470R 1/4W 5% Carbon Film
R4	4K7 1/4W 5% Carbon Film
R5	1K0 1/4W 5% Carbon Film
R6	13K 1/4W 5% Carbon Film
R7	150K 1/4W 5% Carbon Film
R8	3K3 1/4w 5% Carbon Film
R9	4K7 1/4W 5% Carbon Film
R10	4K7 1/4W 5% Carbon Film
R11	3K3 1/4W 5% Carbon Film
R12	18K 1/4W 5% Carbon Film
R13	4K7 1/4W 5% Carbon Film
R14	4K7 1/4W 5% Carbon Film
R15	10K 1/4W 5% Carbon Film
R16	1K5 1/4W 5% Carbon Film
R17	10K 1/4W 5% Carbon Film
R18	2K2 1/4W 5% Carbon Film
R19	10K 1/4W 5% Carbon Film
R20	1K5 1/2W 5% Carbon Film
R21	47K 1/4W 5% Carbon Film
R22	10K 1/4W 5% Carbon Film
R24	100K 1/4W 5% Carbon Film
R25	100R 1/4W 5% Carbon Film
R26	15K 1/4W 5% Carbon Film
R27	100R 1W 5% Carbon Film or Metal Film
R28	100R 1W 5% Carbon Film or Metal Film
R29	220R 1/4W 5% Carbon Film
R30	1K5 1/2W 5% Carbon Film
R31	100K 1/4W 5% Carbon Film
R32	10K 1/4W 5% Carbon Film
R33	2K2 1/4W 5% Carbon Film
R34	22K 1/4W 5% Carbon Film
R35	1K5 1/2W 5% Carbon Film
R36	2K2 1/4W 5% Carbon Film
R37	7R5 1/4W 5% Carbon Film or Metal Film
R38	470R 1/4W 5% Carbon Film
R39	1K0 1/4W 5% Carbon Film
R40	4K7 1/4W 5% Carbon Film
R41	39K 1/4W 5% Carbon Film
R42	39R 1/4W 5% Carbon Film
R43	10K 1/4W 5% Carbon Film
R45	10K 1/4W 5% Carbon Film
R46	27K 1/4W 5% Carbon Film
R47	510R 1/4W 5% Carbon Film
R48	910K 1/4W 5% Carbon Film
R49	100K 1/4W 5% Carbon Film
R50	2K2 1/4W 5% Carbon Film
R51	1K0 1/4W 5% Carbon Film
R52	82K 1/4W 5% Carbon Film
R53	330K 1/4W 5% Carbon Film
R54	10K 1/4W 5% Carbon Film
R55	620R 1/2W 5% Carbon Film
R56	22K 1/4W 5% Carbon Film
R57	10K 1/4W 5% Carbon Film
R58	1K5 1/4W 5% Carbon Film
R65	470R 1/4W 5% Carbon Film
R66	470R 1/4W 5% Carbon Film
RV1	Linear 1 Turn Trimpot 1K0 1/2W (Bourns 3386)
RV2	Linear 1 Turn Trimpot 5K0 1/2W (Bourns 3386)
RV3	Linear 1 Turn Trimpot 500R 1/2W (Bourns 3386)
S1	Power Switch 15A 125VAC (C&K Series CA)
S2	PCB Mount DPDT Slide Switch
T1	Transformer Toroidal 9uH Each Winding (Three Windings With 10.75 Turns Each)
T2	Transformer Toroidal 9uH Each Winding (Two Windings With 10.75 Turns Each)
T3	Current Transformer Toroidal 6uH Secondary (Primary 1.75 Turns, Secondary 9.75 Turns)
T4	Line Transformer 38VAC Secondary With CT (Metcal Part No: MP100-2-536XA 5600-0025)
T5	Current Transformer Bifilar Toroidal 12uH Sec (Primary 1.75 Turns, Secondary 54.75 Turns)
TS1	Overtemperature Switch 170F Normally Closed (Selco OA-170-PCB US-602 S)
U1	Hex Inverter (SN74HC04N)
U2	Dual Voltage Comparator (LM393P)
U3*	Array Of 8 Independent Diodes (MAD1108)
U4*	3-Amp Step Down Switcher (LM2576HVT)
U5	Dual Voltage Comparator (LM393P)
U6	14-Bit Binary Counter & Oscillator (CD4060BE)
U7	Quad 2-Input NOR Gate (CD4001BE)
U8*	Voltage Regulator +18V 1A (MC7818CT)
Y1	Crystal 13.560MHz HC49U (ECX-1570 XX)

NOTES

Solder C7 directly to U4 pins 1 & 3 on rear of PCB.
Make U3 into a 14 pin IC by cutting off pins 1 & 16.
Semiconductors Q3 Q4 U4 U8 & Q1 have heatsinks.
Q4 is double shielded and insulated from heatsink.
Q3 is insulated from heatsink.

! MIRROR VIEW THROUGH BOTTOM OF PCB FOR TROUBLESHOOTING PURPOSES !