TECHNICAL MANUAL

FOR

MF coupler Type ATU 5301

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MF COUPLER

TYPE

ATU 5301

TM 5301/8607

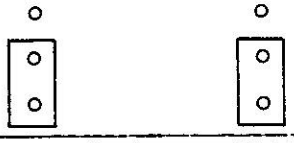
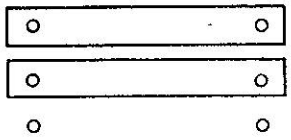
HDBK. 1168/8608
T.M. 5301/8607
12.09.1986

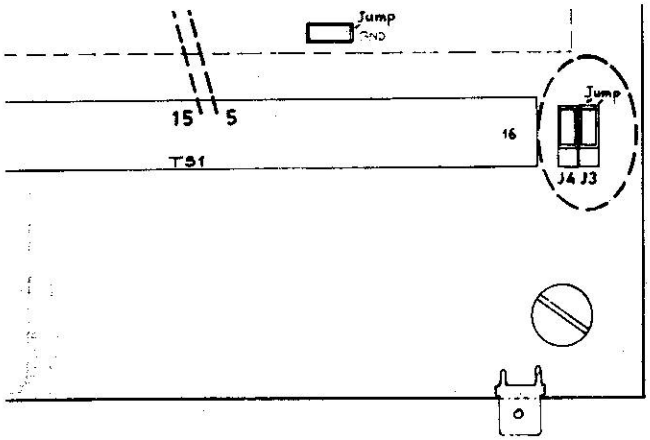
E R R A T A N° 1

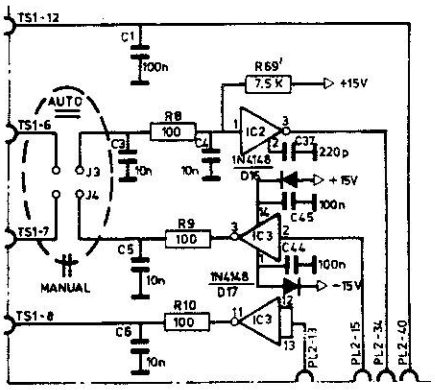
OPERATOR HANDBOOK FOR CONSOLE T9B
TECHNICAL MANUAL FOR MF COUPLER ATU 5301

Concerning manual tuning of the MF coupler ATU 5301, a step has been omitted in the procedure described in above mentioned publications.

Each time you remove connector P2, you have to change the position of jumpers J3 and J5 near terminal strip TS1 of ATU 5301 as described hereafter.

	J 3	J 4
A U T O M A T I C O P E R A T I O N		
M A N U A L O P E R A T I O N		





MF COUPLER

C O N T E N T S

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MF COUPLER
TYPE ATU 5301

1. G E N E R A L

The MF coupler is used to connect the MF transmitter to its antenna and permit an automatic tuning for each frequency selected on the transmitter key-board.

Therefore two separate elements are used, a junction box and the coupler-itself.

The junction box achieves switching between the HF and MF Automatic Tuning Units (ATU).

When mounted in console (SAIT type 9), selection between MF and HF is performed via the interface board.

2. TECHNICAL SPECIFICATIONS

Frequency range : 400 to 535 kHz.

Antenna requirements :

	Components in series				
Capacitance (pF)	250	300	400	500	750
Resistance (ohm)	4.0	5.0	3.0	2.2	1.9

and all Intermediate values.

Antenna tuning : Fully automatic.

Tuning time : Less than 10 sec.

Input impedance after tuning : 50 ohm SWR = 1.4

Adaptive tuning after end of tune when SWR = 2 due to modulation or antenna impedance changes.

Power handling capability : 750 W PEP at 55 % duty cycle and 3 Bd.
400 W Average

Manual setting possible for 500 kHz on 2 antennas.

Operating temperature range typical : - 15°C to + 55°C.

Full performance Temperature range : 0°C to + 40°C.

Power supply range : 24 V + 30/- 10 %

Outline dimensions and weight :

Height : with antenna insulator : 606 mm
: without antenna insulator : 500 mm
Width : 548 mm
Depth : 487 mm
Weight : about 10 kg.

3. I N S T A L L A T I O N

3.1. MOUNTING

For installation be careful to install the ATU as close as possible to the antenna in order that the length of the feeder remains the shortest possible.

3.2. CABLING

The antenna coupler may be distant from the transmitter by as much as 100 m.
Cable type is 18x0,5 mm sq screened for the multiwire cable and RG-213/U as co-axial cable.

3.3. EARTH CONNECTION

Proper and safe operation of the antenna coupler imposes an adequate earthing.

The casing must be connected to earth via the earth bolt by a 100 x 0,5 mm heavy copper strap, kept the shortest possible.

3.4. SYSTEM CHECK

Before using the coupler in operation, verify that all connections are well secured and that the aerial system is in good state.

3.5. FREQUENCY PRE-SETTING

Refer to paragraph 4.2.1 to pre-set the system for manual operation.

4. O P E R A T I O N

4.1. AUTOMATIC OPERATION

Operation of an ATU is essentially fully automatic. The ATU is energized by an order issued from the TUNE function in the control unit (CU) key-board when a new frequency is selected and must be tuned.

When the tuning is satisfactory, the ATU continues to manage the data relative to the correct matching of the aerial and the power amplifier during transmission.

4.2. MANUAL OPERATION

4.2.1. Frequency pre-setting

In order to have marks where to set the viarometer during a manual tuning on 500kHz, the operator has to fix these marks when technical rack is installed.

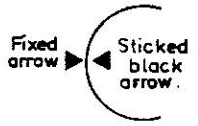
For correct pre-setting operate with technical rack door or cabinet closed.

The ATU has to be preset at first on main antenna, then on emergency antenna. Coloured stickers are deliverd with each ATU.

1° MF ATU on main antenna

Transceiver Control Unit :
- switch on the transceiver
- switch TX ON
- select 500kHz on transmitter display
- depress the key TUNE
- check if full power and SWR OK.

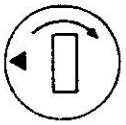
MF Coupler :
- open the ATU
- stick a black arrow on the turning wheel of the variometer very accurately in front of the arrow sticked on the equipment frame (red arrow for reserve ATU, black arrow for main ATU).



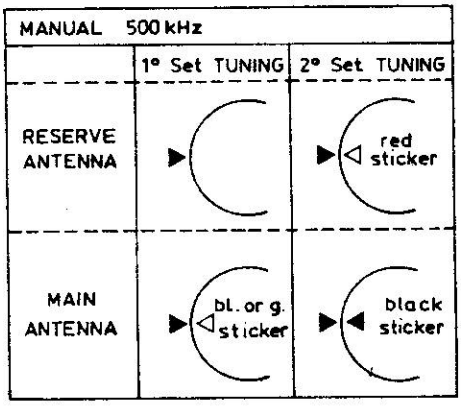
MF COUPLER
TYPE ATU 5301

- Remove connector P2, indicated by the sticker.

- Turn the variometer fully clockwise and be very attentive while listening if the by-pass switch operates, it is indicated by a "click" noise.



° If there is no click :
Stick a blue arrow on the "500kHz preset board" in column "1° set tuning".
° If there is a click :
Stick a green arrow on the same board.

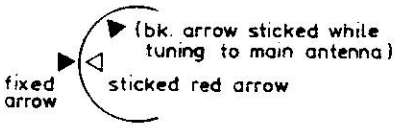


- Fit connector P2 back in place.
- Close the technical rack door.

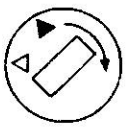
2° MF ATU on emergency antenna

Transceiver Control Unit :
- switch on the transceiver
- switch TX ON
- select 500kHz on transmitter display
- depress the key TUNE
- check if full power and SWR OK.

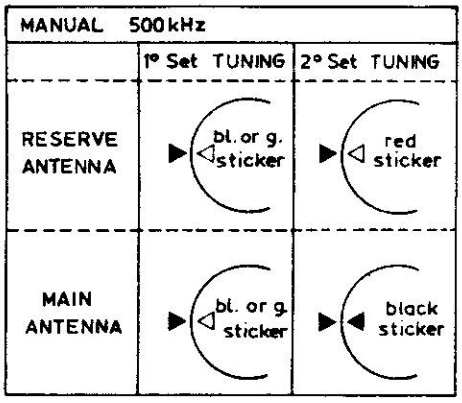
MF Coupler :
- open the ATU
- stick a red arrow on the turning wheel of the variometer very accurately in front of the arrow sticked on the equipment frame.



- Remove connector P2 (see former step).
- Turn the variometer coil fully clockwise and be very attentive while listening if the by-pass switch operates, it is indicated by a "click" noise.



° If there is no click :
Stick a blue arrow on the "500kHz preset board" in column "1° set tuning" in front of RESERVE ANTENNA.
° If there is a click :
Stick a green arrow at this place.



MF COUPLER
TYPE ATU 5301

- Fit connector P2 back in place.
- Close the technical rack door.

4.2.2. Manual tuning

MF Coupler :
- open the ATU
- remove connector P2
- choose which antenna you will use
- according to the chosen antenna, check on the "500kHz preset board" in column "1° set TUNING", which colour (blue or green) corresponds to the antenna and bring the variometer coil to the relevant blue or green terminal position
- bring then the variometer coil back to the position indicated by the coloured (red or black) arrow in column "2° set TUNING"
- close the ATU.

Transceiver Control Unit :
- switch on the transceiver
- switch TX ON
- select 500kHz on transmitter display
- you are ready to send.

To be sure that when the operator has to perform all those operations manually, he knows easily what to do, it is highly recommended that he tries a few times to perform manual tuning in normal circumstances.

Note :

Due to the fact that the variometer turning wheel is scaled, it is possible to preset a tuning value for all MF frequencies.

If the operator wishes to have such a complete tuning chart, he has to make separate "Preset boards" for each frequency and instead of sticking arrows on the turning wheel, he has to note to which graduation corresponds the tuning.

5. TECHNICAL DESCRIPTION

The technical description may be shared among the two units composing the system, the junction box and the ATU.

5.1. JUNCTION BOX

Refer to DWG. N° 2182-12.

The junction box achieves the switching of the 16-core cable arriving from the transmitter unit (TU) and going either to the MF ATU or the HF ATU depending on the frequency selected.

The MF coupler is selected if the MF on data is high at pin TS1-11 of the TU.

The quiescent relays select the HF ATU.

12 of the 16 cores are switched, the next 4 functions are not switched.

- "Ground" at PL1-10.
- "MF ON" at PL1-11.
- "Iant peak measurement" at PL1-2.
- "Iant average measurement" at PL1-3.

For PL1-2 and PL1-3, the current measurement data corresponds to a positive voltage coming from either coupler. Therefore separation diodes are mounted.

RL3 selects which aerial goes to the receiver part of the transceiver system.

5.2. AERIAL TUNING UNIT

Refer to DWG. N° 2182-00 and 10.

An MF aerial is always short compared to the wavelength (about 10 % of the wavelength). Therefore it is capacitive.

The radiation resistance is very low; 0.5 to 1 ohm and for a standard installation, the earth resistance is about 2 ohm. The total resistance is thus between 2 to 4 ohm.

The role of the ATU is to match such an aerial to the 50 ohm transmitter output.

Because the aerial is capacitive, an inductor is inserted in series to achieve resonance.

The greatest and the lowest inductances of the serial inductor are calculated for the extreme frequencies.

The inductor values are 620 uH at 400 kHz and 90 uH at 535 kHz which give a very great $\triangle L$.

Furthermore, the efficiency of the coupler depends on the quality factor of the inductor, therefore the total inductance is in fact formed by more than 1 inductor.

At resonance, the resistance is equal to the resistance of the variometer plus the resistance of the antenna. For a 4 ohm antenna, we observe an equivalent resistance of about 8 ohm. The theoretical efficiency is thus 50 %.

We have to match this resistance with the 50 ohm output resistance of the TU and use therefore an auto-transformer with several tappings covering the range from 4 to 8 ohm.

The data Tune issued at PL1-6 from the control unit goes to pin 34 of the microprocessor board.

The microprocessor takes three actions then :

- Via pin 5 and 7, it resets the auto-transformer to its initial configuration (4 ohm).
- Via pin 9, it inserts a fixed 6 dB attenuator just after SK1 in order that with the TU sending 80 W on 50 ohm, we observe a constant 20 W power.
- Via pin 15 a signal goes to PL1-7 requesting the TU to send the 80 W tuning power.

At this time the servo-system operates to achieve tuning on the frequency.

T5 and T6 are used to check the resonance of the vario-antenna circuit.

T5 is a current detector, T6 is a voltage detector, the capacitor C28 gives a phase shift of 90° of the voltage to be measured.

The diode bridge D12 to D15 is the phase detector.

The resulting component after the RC filter R79/C53 is a DC voltage which is :

- Positive in case of capacitive configuration
- Negative in case of inductive configuration
- Zero in case of matching.

This DC voltage goes to IC14 (pins 15-16) that drives the motor.

IC14 is a pulse width modulator circuit intended to be used for a variety of PWM motor drive and amplifier applications requiring either uni-directional or bi-directional drive circuits. All necessary circuitry is included to generate an analog error signal and modulate two bi-directional pulse train outputs in proportion to the error signal magnitude and polarity.

This monolithic device contains a sawtooth oscillator, error amplifier, and two PWM comparators with ± 100 mA output stages as standard features. Protection circuitry includes under-voltage lockout, pulse-by-pulse current limiting, and a shutdown port with a 2.5 V temperature compensated threshold.

The length during which the motor is driven and the sense of rotation depend on the error voltage coming from the phase detector (output to the FET transistors at pins 4 and 7).

Via the FET transistors TR1 to TR4, the motor is energized rotating the variometer to the left, to the right or leaving it blocked.

The signal at IC14-17 (or TP2) goes to a window comparator where the 0-phase signal (tuning OK) is issued to IC13-5 when the error signal is lower than 0.5 V relative to Vref.

The second input of IC13-4 determines if the output current is too weak or is sufficient to achieve a correct tuning.

The output at IC13-6 to the microprocessor is interpreted as "correct tuning" when the output current is sufficient and there is indeed a zero-phase signal.

In case of 0-phase and sufficient antenna current, the microprocessor allots a 0.1 sec delay before selecting the best tapping to get a 50 ohm input, starting at the lowest value, 4 ohm, and going to the highest value, 8 ohm, unless a good tapping is found meanwhile.

The transformers T1 and T2 are a - 32 dB directional coupler. Direct and reflected voltages are 90°-phase compared in IC4. The result is amplified by IC11 before going to the window comparator formed by two op amps of IC12 and the result at IC13-3 is the data Z OK which informs the microprocessor board that SWR $<$ 1.3.

The data from T1 and T2 are also the inputs IC12-4 (direct voltage) and IC12-5 (reflected voltage).

A standing wave ratio of 3 means that the direct voltage is twice the reflected voltage. Therefore the direct power is divided by two by R31 and R32 before reaching IC12-4. An input at pin 32 of the microprocessor board meaning that the SWR is higher than 3 goes to PL1-8 and is displayed by a flashing led on the CU. Although this function is only enabled when the presence of a sufficient RF power has been detected via IC12-1 to pin 30 of the micro- processor board.

When the data "O-phase OK" and "Z OK" are obtained, the request "TPR" to the TU dissappears and the attenuator is removed.

The ATU continues then to observe the matching during operation and the phase comparator continuously corrects it.

Iant peak is measured by T7 and its associated network, issuing the information to PL1-2.

The fast simplex RX relay RL5 enabling reception on the transmission aerial is energized via PL1-5.

An additional board limiting the voltage to a maximum of 20kV is added at the output of the tuner to the antenna (refer to dwg no. 2182-13).

6. FAULT FINDING

In case of failure of the MF coupler,
- verify the junction box (6-1)
  Refer to dwg no. 2182-12 and 2182-12-1;
- verify the ATU board (6-2).
  Refer to dwg no. 2182-10 and 10-1 for schematic diagram and circuit layout of the board.

6.1. TEST OF JUNCTION BOX

This box is not used in a console T9. In other applications, simply verify that all relays are energized when MF is selected and that no diode (D1 through D4) is blown.

6.2. TEST OF ATU BOARD

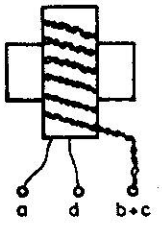
For this test procedure, the ATU board is not mounted.

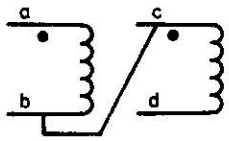
6.2.1. Verification of directional coupler T1-T2

a) Place a 50 ohm non inductive resistor on T4 between tapping a and ground.
b) Put scope probes on coaxes C and B (2182-10-1);
probe on B measures the direct voltage;
probe on C measures the reflected voltage.
c) Enter a 500kHz signal with a 50 ohm generator at the TX connector.
d) Voltage on B should be 40-times lower than voltage on the TX connector.
Voltage on C should be 100-times lower than voltage on B.
e) Remove the 50 ohm resistor.
Voltages on B and C are equal and in phase.
f) Replace the 50 ohm resistor by a short circuit.
Voltages on B and C are equal but in opposite phase.

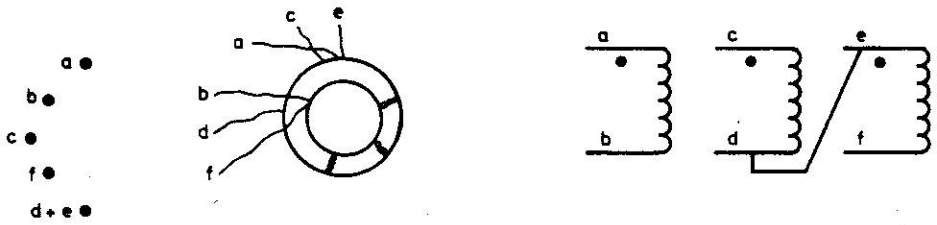
6.2.2. Verification of phase detector T5-T6

Verify correct positioning of the transformers :
a) T5 : b and c must be connected together.



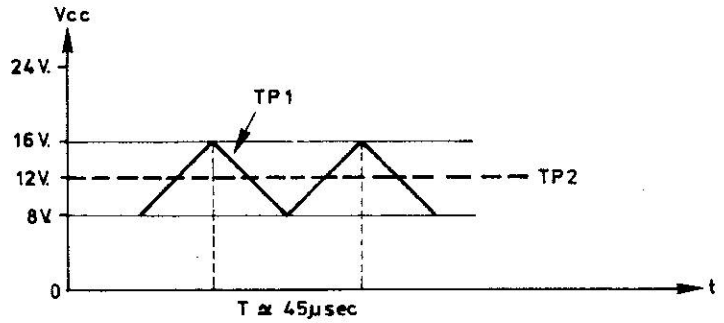


b) T6 : d and e are connected together.



6.2.3. Verification of the Servo-positioning system

- Supply 24VDC (± 1%) to the PC board
  GND at TS1-10 and +24V at TS1-14/15.
- Connect a scope probe at TP1 and observe the sawtooth signal.



Period T is about 45 µsec.

- DC voltage at TP2 is 12VDC ± 3%.
- DC voltage at IC14-8 is 16,05 VDC ± 3%
  IC14-10 is 7,94 VDC ± 3%
- DC voltage at IC6-7 is 14,90 VDC ± 3%
  IC6-4 is 9,10 VDC ± 3%

7. PARTS LIST

7.1. Numbering

Each component is separately identified - example : R2 for resistor.

In the circuit diagrams, each terminal is identified by a number or a letter - example PL2-3, which means point 3 of plug 2. Moreover the function is generally added - example : + 24 V DC.

7.2. Abbreviations

A	= ampere, amperes	PL	= connector (plug)
C	= capacitor	Polyc.	= polycarbonate
Car.	= carbon	Polyes.	= polyester
Cer.	= ceramic	Polyst.	= polystyrene
D	= diode	PTC	= pos. temp. coef.
Elect	= electrolytic capacitor	R	= resistor
		RL	= relay
F	= Farad	RS	= resistor safety
FS	= fuse	S	= switch
FSX	= fuse holder	SK	= connector (socket)
H	= Henry		
IC	= integrated circuit	SL	= lamp
		T	= transformer
k	= kilo or 10^3	Tan.	= tantalum capacitor
L	= inductor		
lin.	= linear	TR	= transistor
log.	= logarithmic	V	= working voltage DC or Volts
LS	= loudspeaker		
M	= mega or 10^6	V1...	= valve
m	= milli or 10^{-3}	Vac	= working voltage AC
ME	= meter		
MF	= metal film	Var.	= variable
Mi	= mica	Varicap	= variable capac. diode
MP	= metallized paper		
MPF	= metallized polyethilene	Vpp	= peak to peak volt
		W	= watt
u	= micro or 10^{-6}	W. Alum.	= wet aluminium electr.
n	= nano 10^{-9}		
NPO	= temp. coef. 0	WW	= wire wound
N150	= temp. coef. -150	X	= crystal, crystal oscillator or crystal filter.
NTC	= neg. temp. coef.		
p	= pico or 10^{-12}		
P	= potentiometer		
PCB	= printed circuit board		

PARTS LIST FOR

ATU BOARD

DWG. NO. 2182-10D

RESISTORS

R1-2	NOT USED				
R3-4	330	7W	5%	WW	263.238
R5-6	68	7W	5%	WW	263.239
R7	150	7W	5%	WW	263.237
R8-10	100	0.35W	1%	MF	268.694
R11	NOT USED				
R12	2 X 150 //	0.35W	1%	MF	267.502
R13	120	0.35W	1%	MF	268.671
R14	75	0.35W	1%	MF	267.547
R15-16	1K	0.35W	1%	MF	268.690
R17	82	0.35W	1%	MF	267.837
R18	91	0.35W	1%	MF	267.544
R19	82	0.35W	1%	MF	267.837
R20	2K2	0.35W	1%	MF	268.691
R21-24	NOT USED				
R25	10K	0.35W	1%	MF	268.699
R26a-b	4.7K	0.35W	1%	MF	268.692
R27-28	1K	0.35W	1%	MF	268.690
R29	7K5	0.35W	1%	MF	269.697
R30	300	0.35W	1%	MF	267.516
R31	strap				
R32-33	82K	0.35W	1%	MF	267.553
R34	100	0.35W	1%	MF	268.694
R35	NOT USED				
R36	100	0.35W	1%	MF	268.694
R37	24K	0.35W	1%	MF	268.698
R38	NOT USED				
R39	100	0.35W	1%	MF	268.694
R40	4K7	0.35W	1%	MF	268.692
R41	3K	0.35W	1%	MF	268.689
R42	4K7	0.35W	1%	MF	268.692
R43	10K	0.35W	1%	MF	268.699
R44	NOT USED				
R45	10K	0.35W	1%	MF	268.699
R46-47	NOT USED				
R48-49	1K	0.35W	1%	MF	268.690
R50	7K5	0.35W	1%	MF	267.838
R51	5K6	0.4W	1%	MF	268.623
r52	7K5	0.35W	1%	MF	267.838
R53	24K	0.35W	1%	MF	268.698
R54	20K	0.4W	2%	MF	267.539

DWG. NO. 2182-10D

R55	1M	0.4W	2%	MF	269.751
R56	2 x 100 //	0.4W	2%	MF	269.651
R57	24K	0.35W	1%	MF	268,698
R58	15K	0.35W	1%	MF	267.549
R59	10K	0.35W	1%	MF	268.699
R60-61	5K1	0.35W	1%	MF	267.533
R62	10K	0.35W	1%	MF	268.699
R63	2K4	0.35W	1%	MF	267.574
R64	7K5	0.35W	1%	MF	267.838
R65	470	0.35W	1%	MF	267.506
R66	100	0.35W	1%	MF	268.694
R67	47	0.35W	1%	MF	267.542
R68-69	4K7	0.35W	1%	MF	268.692
R69'	7K5	0.35W	1%	MF	267.838
R70	5K1	0.35W	1%	MF	268.918
R71	4K7	0.35W	1%	MF	268.692
R72	47K	0.35W	1%	MF	267.592
R73	NOT USED				
R74	47K	0.35W	1%	MF	267.592
R75	10K	0.35W	1%	MF	268.699
R76-78	NOT USED				
R79	470	0.35W	1%	MF	267.506
R80	100K	0.35W	1%	MF	268.664
R81	47K	0.35W	1%	MF	267.592
R82	1K5	0.4W	2%	MF	269.680
R83-86	47K	0.35W	1%	MF	267.592
R87	22K	0.35W	1%	MF	267.515
R88	2K	0.35W	1%	MF	268.693
R89	47K	0.35W	1%	MF	267.592
R90-99	NOT USED				
R100	4K7	0.35W	1%	MF	268.692
R101	1K	0.35W	1%	MF	268.690
R102-103	NOT USED				
R104	22K	0.35W	1%	MF	267.515
R105-111	NOT USED				
R112	2K	0.35W	1%	MF	268.693
R113	100K	0.35W	1%	MF	268.664
R114	51	0.35W	1%	MF	267.537
R115	100K	0,4W	2%	MF	269.726

DWG. NO. 2182-10D

CAPACITORS

C1	100nF	10%	63V	Cer.	254.795
C2	NOT USED				
C3-6	10nF	10%	100V	Cer.	252.575
C7	100nF	10%	63V	Cer.	254.795
C8	10nF	10%	100V	Cer.	252.575
C9	NOT USED				
C10-11	100nF	10%	63V	Cer.	254.795
C12	NOT USED				
C13	100nF	10%	63V	Cer.	254.795
C14	10nF	10%	100V	Cer.	252.575
C15-16	100nF	10%	63V	Cer.	254.795
C17-18	4.7nF	5%	63V	Cer.	252.363
C19	NOT USED				
C20	10nF	2%	63V	Cer.	252.189
C21-22	2.2nF	20%	50V	Cer.	252.934
C23	10nF	2%	63V	Cer.	252.189
C24	56pF	2%	500V	Cer.	252.551
C25-26	NOT USED				
C27	4.7nF	5%	63V	Cer.	252.363
C28	270pF	10%	100V	Cer.	252.018
C29	100nF	20%	100V	Cer.	252.583
C30	100nF	10%	63V	Polyes.	254.795
C30'	10uF	20%	35V	Tan.	255.313
C31	2.2nF	20%	50V	Cer.	252.934
C32	220nF	10%	63V	Cer.	252.378
C33	1nF	10%	63V	Cer.	252.324
C34	10nF	10%	100V	Cer.	252.575
C35	100nF	10%	63V	Cer.	254.795
C36	NOT USED				
C37-38	220pF	10%	100V	Cer.	252.897
C39-42	100nF	10%	63V	Cer.	254.795
C43	NOT USED				
C44-51	100nF	10%	63V	Cer.	254.795
C52	NOT USED				
C53	22nF	5%	100V	Cer.	252.117
C54-55	22nF	20%	50V	Cer.	252.009
C56-57	470pF	10%	100V	Cer.	252.022
C58-59	NOT USED				
C60	470nF	10%	50V	Cer.	252.102
C61	1uF	20%	35V	Tan.	255.403
C62	680pF	10%	100V	Cer.	252.123
C63	1uF	10%	50V	Polyes.	254.669
C64	1nF	10%	100V	Cer.	252.896
C65	100nF	1%	63V	Cer.	254.795

DWG. NO. 2182-10D

DIODES

D1-2	1N4148			258.726
D3	NOT USED			
D4-5	BZX79C5V1	ZENER		285.856
D6	SD103A			284.340
D7	NOT USED			
D8	1N4148			285.726
D9-11	NOT USED			
D12-17	1N4148			285.726
D18	SD103A			284.340
D19-22	NOT USED			
D23-24	1N4148			285.726
D25-28	BZX79C18	ZENER		285.993
D29-32	BZX79C13	ZENER		286.316

COILS

L1	25uH	3A		275.051
L2	4.7uH	Ferroperm		275.058
L3-L4	NOT USED			
L5-6	68uH	Cambion		275.112

INTEGRATED CIRCUITS

IC1	NOT USED			
IC2	MC 1489AN			289.883
IC3	MC 1488N			289.880
IC4	MIXER SBL-1			275.276
IC5	LM 324N			288.304
IC6	LM 339N			288.044
IC7	ULN 2004A			288.864
IC8-10	NOT USED			
IC11	LM 324N			288.304
IC12	LM 339N			288.044
IC13	74HCOON			289.746
IC14	UC 3637N			289.973

RELAYS

RL1-3	EBERLE	24VDC	2 INV	279.612
RL4	NOT USED			
RL5	CLARE	24VDC	N.C.	279.607

DWG. NO. 2182-10D

TRANSFORMERS

T1-2	SAIT Manufactured	
T3	NOT USED	
T4-7	SAIT Manufactured	

TRANSISTORS

TR1-2	IRF 9510	287.896
TR3-4	IRF 513	287.895

PARTS LIST FOR

MICROPROCESSOR BOARD

DWG. NO. 2182-11

RESISTORS

R1	47K	0.35W	1%	MF	267.592
R2	10K	0.35W	1%	MF	268.699
R3-4	180	0.35W	1%	MF	268.695
R5-7	NOT USED				
R8-12	47K	0.35W	1%	MF	267.592
R13	33	2.50W	5%	MF	269.380

CAPACITORS

C1	22nF	10%	50V	Cer.	252.063
C2-3	22pF	10%	200V	Cer.	252.312
C4	10uF	20%	35V	Tan.	255.169
C5-10	22nF	10%	50V	Cer.	252.063
C11	NOT USED				
C12	10uF	20%	35V	Tan.	255.169
C13	100nF	20%	50V	Cer.	252.001
C14-16	22nF	10%	50V	Cer.	252.063

DIODES

D1	1N4148		285.726
D2	MV5752	RED LED	286.472
D3	MV5354	YELLOW LED	286.496

CRYSTAL

X1	Xtal	2457,600 kHz	210.582

DWG. NO. 2182-11

INTEGRATED CIRCUITS

IC1	HD 6303 RP	289.798
IC2	AM 26LS31DC	289.743
IC3	AM 26LS32PC	289.702
IC4	NOT USED	
IC5	SN74HC373N	289.931
IC6	MM 74HC04N	289.678
IC7	HD 6321P	289.691
IC8	NOT USED	
IC9	MBM-27C64-252	289.649
IC10	UA 7805CKC	289.119
IC11	NOT USED	
IC12	MM 74HC10N	289.930
IC13	MM 74HC244N	289.736

PARTS LIST FOR

JUNCTION BOX

DWG. NO. 2182-12

CAPACITORS					
C1-3	10nF	50V	10%	Cer.	252.058
DIODES					
D1-4	1N4148				285.726
RELAYS					
RL1-2	ITT PZ26A2820				
RL3	POTTER/BRUMFIELD		RK5W24		
RESISTOR					
R1	50	1%	0.35W	MF	267.537

PARTS LIST FOR

20kV DETECTOR BOARD

DWG NO. 2182-13

RESISTORS

R1	18K	0,35W	1%	MF	267.610
R2	200	0,35W	1%	MF	267.541

CAPACITORS

C1	150pF	630V	1%	Polyst.	254.094
C2-3	22 nF	50V	10%	Cer.	252.063
C4	470pF	630V	1%	Polyst.	254.123

DIODE

D1	1N4148				285.726

PARTS LIST FOR

BREAK-IN RELAY BOARD

DWG. NO. 2182-10

RESISTORS

R1	10K	0.35W	1%	MF	286.699
R2	3K	0.35W	1%	MF	286.689
R3	100K	0.35W	1%	MF	268.664
R4	300K	0.4W	2%	MF	269.737
R5	470Ω	0.35W	1%	MF	268.692

CAPACITORS

C1	10uF	100V	10%	Cer.	252.575
C2	1uF	50V	10%	Polyes.	254.669
C3	100nF	100V	20%	Cer.	252.583

DIODES

D1-2	1N4148	285.726
D3	1N4007	285.419

TRANSISTORS

TR1-2	BC107	285.302
TR3	BC140-16	287.008

INDUCTOR

L1	4.7uH	Ferroperm	1.3A	275.058

RELAY

RL1	EBERLE	24VDC	2INV	279.612