SERVICE INSTRUCTION

NAFP15

MODULATION MONITOR PROBE

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LIST OF EFFECTIVE PAGES

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Original . . . . 15 January 1986

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NAFP15
MODULATION MONITOR PROBE

INTRODUCTION

1. The NAFP15 modulation monitor probe is an option for Nautel's AMPFET 2.5, 5 and 10 AM broadcast transmitters. The probe monitors the rf voltage output of the transmitter and provides a low voltage sample of the rf output for a station modulation monitor. Taps on an autotransformer and 3 potentiometers provide for the low voltage sample to be set to the same amplitude (approximately 5 volts rms) for high, low 1 and low 2 operating levels of the transmitter.

1.1 The NAFP15 modulation monitor probe may be factory installed or field retrofitted on delivered transmitters.

FACTORY EXCHANGE/REPAIR SERVICE

2. Nautel provides a factory module exchange/repair service for users of Nautel's AMPFET series of transmitters. Users who do not have repair facilities, or who are not able to repair a module, may utilize this service for a nominal fee.

MECHANICAL CONFIGURATION

3. The NAFP15 modulation monitor probe uses a formed metal chassis and is mounted on pillars on the top of the transmitter's output filter. A sleeved lead with an attached lug is used to connect the probe to the rf output of the transmitter: other connections are made to the 12-way barrier strip and to a 6 way connector on the top of the assembly. Refer to figure 2 for assembly detail of the NAFP15 modulation monitor probe.

THEORY OF OPERATION (Refer to figure 1)

4. The rf voltage output of the transmitter is applied to autotransformer T1. Seven step-down taps of T1 are connected to terminals of TB1.

4.1 The high level output terminal (TB1-3) is connected to the appropriate terminal on TB1 that will provide approximately five volts rms at TB1-2 when the transmitter is in its high level operating mode; i.e., relays K1 and K2 are de-energized. Potentiometer R3 is adjusted to set the high level output to 5V rms (See formula used to determine step-down tap selection in paragraph 6.)

4.2 The low level 1 output level terminal (TB1-7) is connected to the appropriate terminal on TB1 that will provide an rms voltage that is equal to or greater than the high level output when the transmitter is in its low level 1 operating; i.e., K1 is energized while K2 is de-energized. Potentiometer R2 is adjusted to set the low level 1 output to the same amplitude as the high level output.

4.3 The low level 2 output level terminal (TB1-12) is connected to the appropriate terminal on TB1 that will provide an rms voltage that is equal to or greater than the high level output when the transmitter is in its low level 2 operating mode; i.e., K1 is de-energized and K2 is energized. Potentiometer R1 is adjusted to set the low level 2 output to the same amplitude as the high level output.

4.4 The coil of K1 is controlled by transistor Q1 while the coil of K2 is controlled by transistor Q2. When the transmitter is in low level 1 operating mode, the low level 1 control at J1-3 will be at (+15V) while the low level 2 control (J1-4) will be at ground. These controls are fed from the NAPC18 ALC circuit. Components R4, C2, R5 and R6, C3, R7 act as filtering and attenuation for their associated control signal. +15V on the low level 1 control will turn Q1 on. This energizes relay K1. When the transmitter is in low level 2 operating mode, the control signal on J1-4 is (+15V) while J1-3 is at ground. This turns on transistor Q2 energizing relay K2. When in high power mode, both control inputs are at ground and both relays remain de-energized. The low power control output on J1-5 can be used to drive an external relay. CR3, CR4 and CR5, isolate the external relay from K1 and K2. This output can be controlled by the low power 1 signal or low power 2 signal depending on the position of the links between LL1, LP and LL2.

4.5 The output of the modulation monitor probe must be terminated into a 50 ohm load, normally the 50 ohm input of a station modulation monitor.

INSTALLATION

5. When the NAFP15 modulation monitor probe is to be installed as a field retrofit, observe the following:

(a) Switch off the transmitter.

WARNING

Extremely high voltages that may cause serious injury or death are present at the transmitter's rf output when the transmitter is turned on.

(b) Remove four screws and four plastic cup washers securing top cover on transmitter and lift off top cover.

(c) Remove four screws and four plastic cup washers securing upper, rear panel of transmitter and remove panel.

(d) Remove 10 screws and 10 lock washers securing rear cover on transmitter's harmonic filter assembly and remove cover.

(e) Position NAFP15 modulation monitor probe over mounting holes in top of harmonic filter assembly as depicted in figure 3 or 4, and secure using four screws, four washers and four nuts.

(f) Install rear cover on harmonic filter assembly, removed in step (d), using 10 screws and 10 lock washers.

CAUTION

Ensure attaching hardware is firmly tightened.

(g) Remove the nut securing the rf output coaxial cable to the spark gap assembly and install the lug-terminated rf input lead of the NAFP15 modulation monitor probe on the rf output coaxial cable's mounting bolt.

NOTE

It is recommended that the rf output coaxial cable's terminating lug be located adjacent to the spark gap assembly bracket.

(h) Install the nut removed in step (g), ensuring it is firmly tightened.

(i) Connect a coaxial cable from the station modulation monitor to terminal board TB1 of the modulation monitor probe, ensuring the conductor is connected to TB1-2 and the shield is connected to TB1-1.

(j) For field modifications, a six pin connector and interconnecting wiring will be provided with the NAFP15 modulation monitor probe. The six pin connector will mate with J1 on the NAFP15. Connect the control wires to their destination in the transmitter as detailed in the field modification instructions.

SELECTION OF AUTOTRANSFORMER TAPS

6. Determine the tap selections of autotransformer T1 that will provide the same rms voltage, in both high and low operating levels; at the amplitude required by the station modulation monitor to be used, as follows: For example of calculations, refer to the bottom of page 5.

(a) Determine the intended rf carrier output level of the transmitter for the high, low 1 and low 2 operating levels.

(b) Determine the station modulation monitor's desired input signal level, in rms volts.

(c) Calculate the high level input voltage to the modulation monitor probe using the following formula:

$$\sqrt{P \times R_L} = V_{in}$$

where: P = rf carrier output level of transmitter in Watts.

R_L = transmitter's rf output terminating impedance (50 ohms).

V_{in} = amplitude of rf input voltage to modulation monitor probe in rms volts.

(d) Calculate the reduction, in dB, required to produce the modulation monitor probe's required output voltage, in high level operation, using the following formula:

$$20 \log \left(\frac{V_{out}}{V_{in}} \right) = X \text{ dB}$$

where: V_{out} = required output voltage of modulation monitor probe in rms volts

V_{in} = amplitude of rf input voltage to modulation monitor probe in rms volts

X dB = reduction required in dB

(e) Refer to table 1 and determine the tap of autotransformer (on TB1) that will provide the desired or next lower reduction, in dB, to the resultant of step (d).

(f) Connect a jumper wire between TB1-3 (HIGH) and the terminal of TB1 determined in step (e).

(g) Calculate the low level 1 input voltage to the modulation monitor probe using the formula in step (c).

(h) Calculate the reduction, in dB, required to provide an output voltage that is equal to, or slightly greater than, the output voltage in high level operation using the formula in step (d).

(i) Refer to table 1 and determine the tap of autotransformer T1 (on TB1) that will provide the desired or next lower reduction in dB's, to the resultant in step (h)

(j) Connect a jumper wire between TB1-7 (LOW 1) and the terminal of TB1 determined in step (i).

Table 1 Autotransformer T1 Tap Selection

TB1 TERMINAL	OUTPUT INTO 50 OHMS RELATIVE TO TRANSMITTER OUTPUT dB
4	-46
5	-41
6	-37
8	-35
9	-33
10	-31.5
11	-30.5

(k) Calculate the low level 2 input voltage to the modulation monitor probe using the formula in step (c).

(l) Calculate the reduction, in dB, required to provide an output voltage that is equal to, or slightly greater than, the output voltage in high level operation using the formula in step (d).

(m) Refer to table 1 and determine the tap of autotransformer T1 (on TB1) that will provide the desired or next lower reduction in dB's, to the resultant in step (l)

(n) Connect a jumper wire between TB1-12 (LOW 2) and the terminal of TB1 determined in step (m).

EXAMPLE OF TAP SELECTION FOR TYPICAL TRANSMITTER

Intended high level rf carrier output = 10,000 Watts
Intended low level 1 rf carrier output = 5,000 Watts
Intended low level 2 rf carrier output = 1,000 Watts
Required modulation monitor input level = 5.0 volts rms

step (c) $\sqrt{10{,}000 \times 50} = 707$ volts rms

step (d) $20 \log \left(\frac{5.0}{707}\right) = -43$ dB

step (f) connect TB1-1 (HIGH) to TB1-5

step (g) $\sqrt{5{,}000 \times 50} = 500$ volts rms.

step (h) $20 \log \left(\frac{5.0}{500}\right) = -40$ dB

step (j) Connect TB1-7 (LOW 1) to TB1-6

step (k) $\sqrt{1{,}000 \times 50} = 224$ volts rms.

step (l) $20 \log \left(\frac{5.0}{224}\right) = -31.4$ dB

step (n) Connect TB1-12 (LOW 2) to TB1-11

CALIBRATION/TESTING

7. Calibrate and test the modulation monitor probe as follows:

NOTE

The output of the modulation monitor probe must be terminated into a 50-ohm load to function properly.

(a) Verify autotransformer tap selection has been completed as detailed in paragraph 6.

(b) Set modulation monitor probe's potentiometers (R1, R2 and R3) fully clockwise.

(c) Connect modulation monitor probe's output coaxial cable to a 50-ohm load (input of modulation monitor).

(d) Connect an rf voltmeter to the station modulation monitor's input, to measure the modulation monitor probe's output voltage, using a T-connector, if necessary.

CAUTION

It is recommended that the transmitter's high power rf output level be reduced at initial turn-on and slowly increased, while monitoring the amplitude of the modulation monitor probe's output, to ensure the maximum level of the modulation monitor is not exceeded.

(e) Turn the transmitter on, in its high level operating mode, and verify the transmitter is producing the intended high level, rf carrier output.

WARNING

High voltages that may cause serious injury or death are present in the transmitter's harmonic filter when the transmitter is turned on. Use extreme caution when making adjustments to potentiometers R1, R2 and R3.

(f) The modulation monitor probe's output, as indicated on the rf voltmeter, should be approximately the required input voltage of the modulation monitor. To obtain precisely the required input voltage, adjust R3 of the modulation monitor probe, counterclockwise using extreme caution.

NOTE

If the voltmeter indication in step (f) is greater than desired after R3 has been adjusted, turn transmitter off, connect TB1-3 (HIGH) to the tap on TB1 that will provide the next greater reduction and then repeat steps (e) and (f).

If the voltmeter indication in step (f) is less than desired after R3 has been adjusted, turn transmitter off, connect TB1-3 (HIGH) to the tap on TB1 that will provide the next lower reduction and then repeat steps (e) and (f).

(g) Set transmitter to its low level operating modes and verify the transmitter is producing the intended low level 1 and low level 2 rf carrier output.

(h) The rf voltmeter's indications should be equal to, or greater than, the reading obtained in step (f).

NOTE

If low power 1 reading in step (h) is less than the reading is step (f), turn transmitter off, connect TB1-7 to the tap on TB1 that will provide the next lower reduction and repeat step (h). If low power 2 reading is less than the reading in step (f), turn transmitter off, connect TB1-12 to the tap on TB1 that will provide the next lower reduction. Repeat step (h).

(i) With the transmitter in low level 1 mode and using extreme caution, adjust potentiometer R2, of modulation monitor probe, counterclockwise until rf voltmeter indication is precisely the same as the high level reading obtained in step (f).

(j) With the transmitter in low level 2 mode and using extreme caution, adjust potentiometer R1, of modulation monitor probe, counter clockwise until rf voltmeter indication is precisely the same as the high level reading obtained in step (f).

(k) Turn transmitter off and replace top cover on transmitter using four screws and four plastic cup washers. Ensure screws are firmly tightened.

PARTS LIST

8. Table 2 provides a parts list for the electrical parts in the modulation monitor probe.

Table 2 - NAFP15 Reference Designation Index

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL'S PART NO.	JAN, MIL OR MFR PART NO.	(OEM) MFR CODE
-	Modulation Monitor Probe Assembly	NAFP15	139-6151	37338
C1	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL	56289
C2	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL	56289
C3	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL	56289
CR1	Diode, General Purpose, Small Signal	QAP29	1N4938	01295
CR2	Diode, General Purpose, Small Signal	QAP29	1N4938	01295
CR3	Diode, General Purpose, Small Signal	QAP29	1N4938	01295
CR4	Diode, General Purpose, Small Signal	QAP29	1N4938	01295
CR5	Diode, General Purpose, Small Signal	QAP29	1N4938	01295
CR6	Diode, General Purpose, Small Signal	QAP29	1N4938	01295
F1	Fuse, 0.25A, 250V, Type 3AG	FC06	312.250	75915
J1	Connector, Plug, 6-pin	JD09	P-3306-AB	13150
K1	Relay, 24Vdc Coil	KAP05	1315-4C-24D	73949
K2	Relay, 24Vdc Coil	KAP05	1315-4C-24D	73949
L1	Toroid	LY09	11-122-B	33062
Q1	Transistor, NPN, Darlington	QA06	2N6295	04713
Q2	Transistor, NPN, Darlington	QA06	2N6295	04713
R1	Resistor, Variable, 100 ohms, 2W	RV15	RV4LAYSA101A	44655
R2	Resistor, Variable, 100 ohms, 2W	RV15	RV4LAYSA101A	44655
R3	Resistor, Variable, 100 ohms, 2W	RV15	RV4LAYSA101A	44655
R4	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G	36002
R5	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G	36002
R6	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G	36002
R7	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G	36002
T1	Transformer	139-6099	139-6099	37338
TB1	Terminal Block, Barrier, 12-terminal	JB14	12-140Y	71785
XF1	Fuseholder, Panel, Type 3AG Fuse	BAP30	342012A	75915
XK1	Relay Socket	KA19	1310-1ST	73949
XK2	Relay Socket	KA19	1310-1ST	73949

Table 3 - Wiring List

SOURCE	DESTINATION	CODE		SIZE	FUNCTION
J1-1	J1-2	Capacitor	CCG04	0.01uF	C1
Q1-E	Q1-B	Capacitor	CCG04	0.01uF	C2
Ground	Q2-B	Capacitor	CCG04	0.01uF	C3
XK1-13 Cathode	XK1-14 Anode	Diode	QAP29	1N4938	CR1
XK2-13 Cathode	XK2-14 Anode	Diode	QAP29	1N4938	CR2
XK1-14 Anode	XK1-10 Cathode	Diode	QAP29	1N4938	CR3
XK2-14 Anode	XK2-10 Cathode	Diode	QAP29	1N4938	CR4
Q1-C Cathode	TT4 Anode	Diode	QAP29	1N4938	CR5
Q2-C Cathode	TT2 Anode	Diode	QAP29	1N4938	CR6
Q1-B	TT-5	Resistor	RAP13	10K ohms	R4
Q1-E	Q1-B	Resistor	RAP11	3.3K ohms	R5
Q2-B	TT-1	Resistor	RAP13	10K ohms	R6
Ground	Q2-B	Resistor	RAP11	3.3K ohms	R7
J1-1	XK1-13	-	Red	22	*
R1-1	TB1-12	1	White	22	
R2-1	TB1-7	2	White	22	
R3-1	TB1-3	3	White	22	
R1-3	XK1-1	4	White	22	
R2-3	XK1-8	5	White	22	
R3-3	XK1-4	6	White	22	
XK1-9	XK2-8	7	White	22	
XK1-12	XK2-4	8	White	22	
XK2-12	XF1-Centre	9	White	22	
XF1-Side	TB1-2	10	White	22	
TT1	J1-4	11	White	22	
TT5	J1-3	12	White	22	
Q2-C	XK2-10	13	White	22	
Q1-C	XK1-10	14	White	22	
TT3	J1-5	15	White	22	
XK1-13	XK2-13	16	Red	22	
Q1-E	Ground	Tinned Copper		22	Jumper
Q2-E	Ground	Tinned Copper		22	Jumper
TB1-1	Ground	Tinned Copper		22	Jumper
J1-2	Ground	Tinned Copper		22	Jumper
J1-6	Ground	-	Black	22	Jumper
R1-1	R1-2	Tinned Copper		22	Jumper
R2-1	R2-2	Tinned Copper		22	Jumper
R3-1	R3-2	Tinned Copper		22	Jumper

* Denotes passes thru LY09 toroid (2 turns)

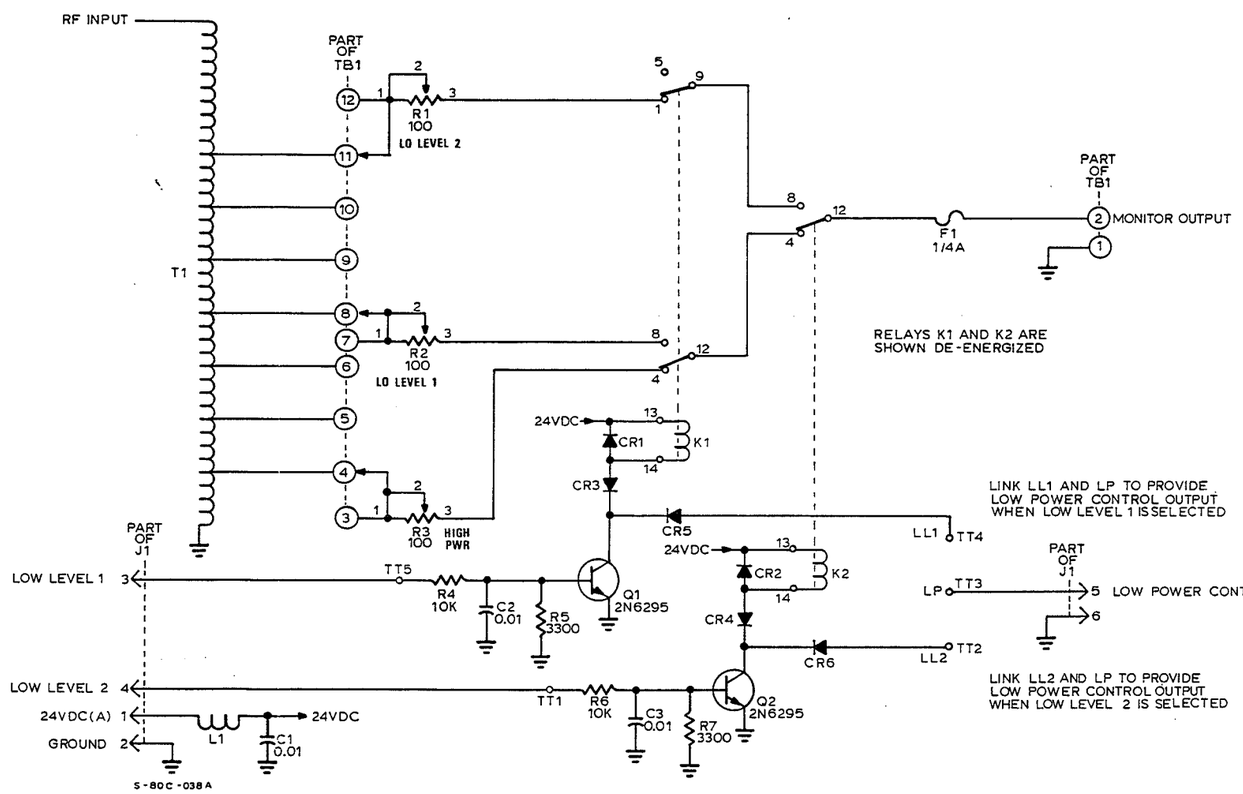
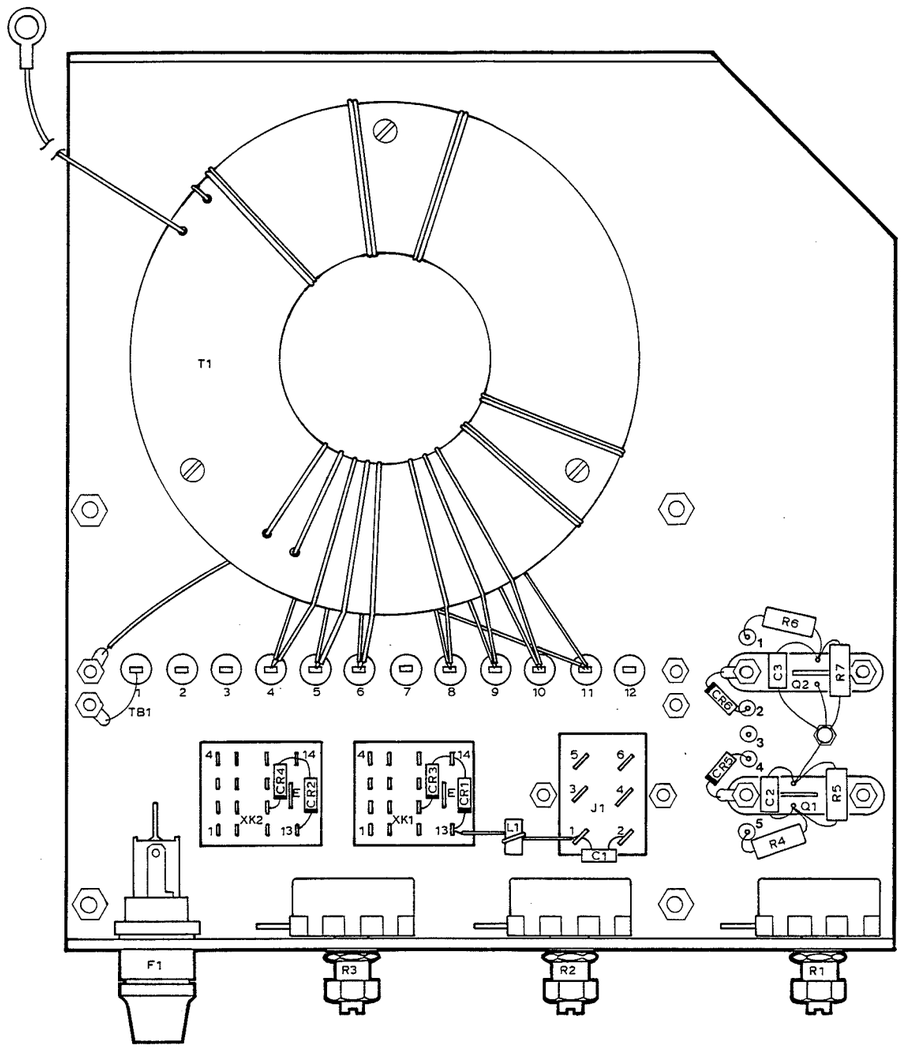


Figure 1 Electrical Schematic - NAFP15 Modulation Monitor Probe



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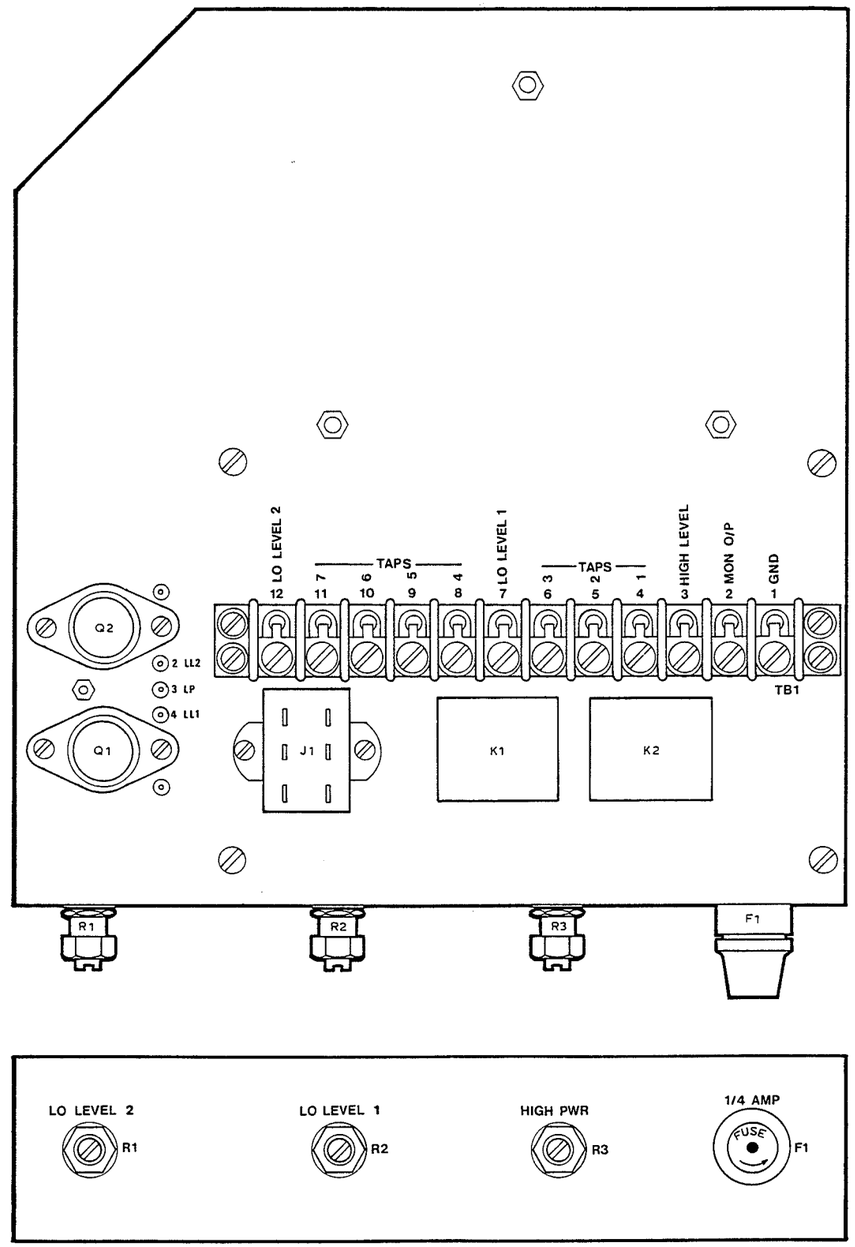

Figure 2 Assembly Detail - NAFP15 Modulation Monitor Probe

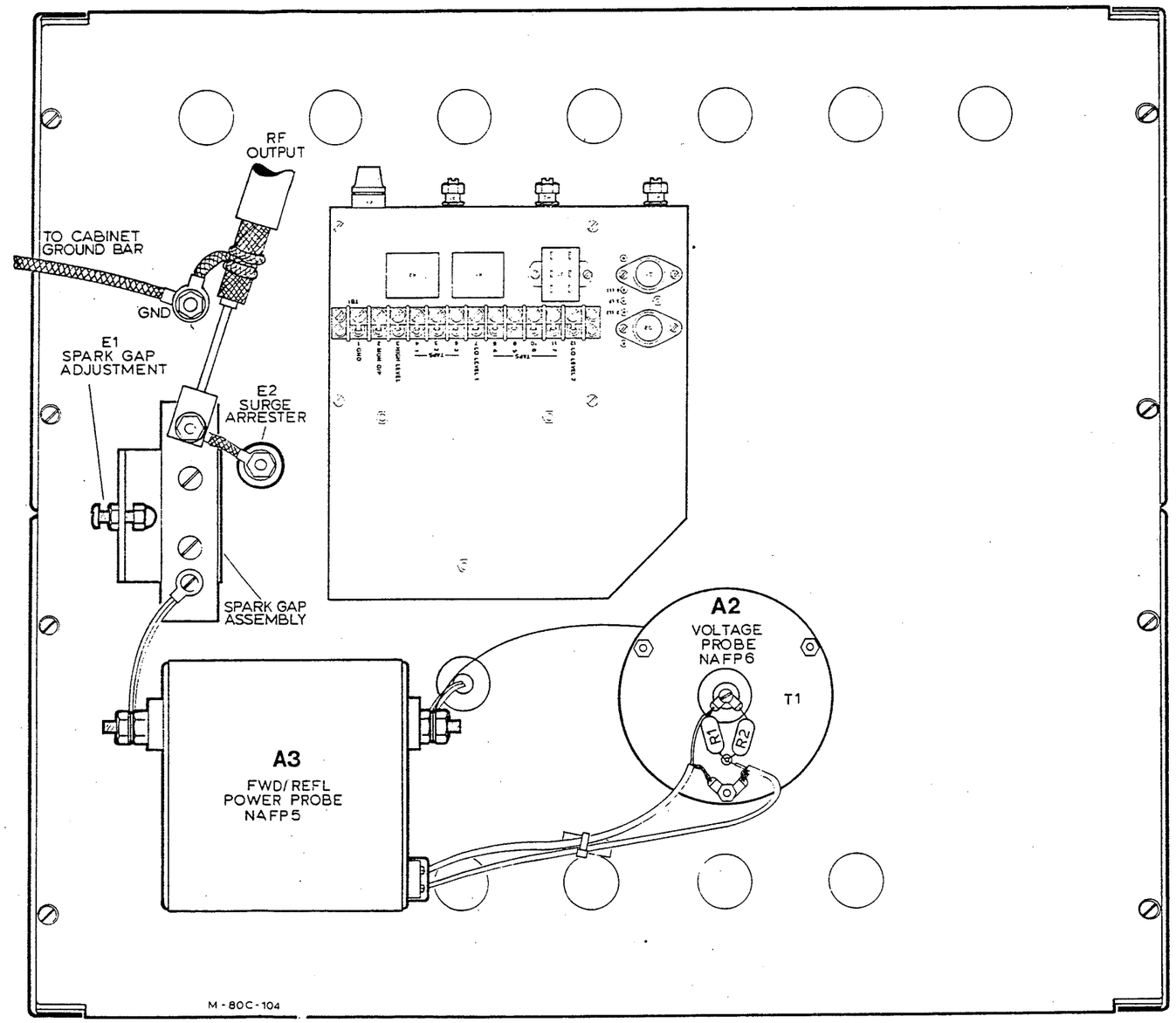

Figure 3 NAF27 Harmonic Filter showing location of NAFP15 Modulation Monitor Probe

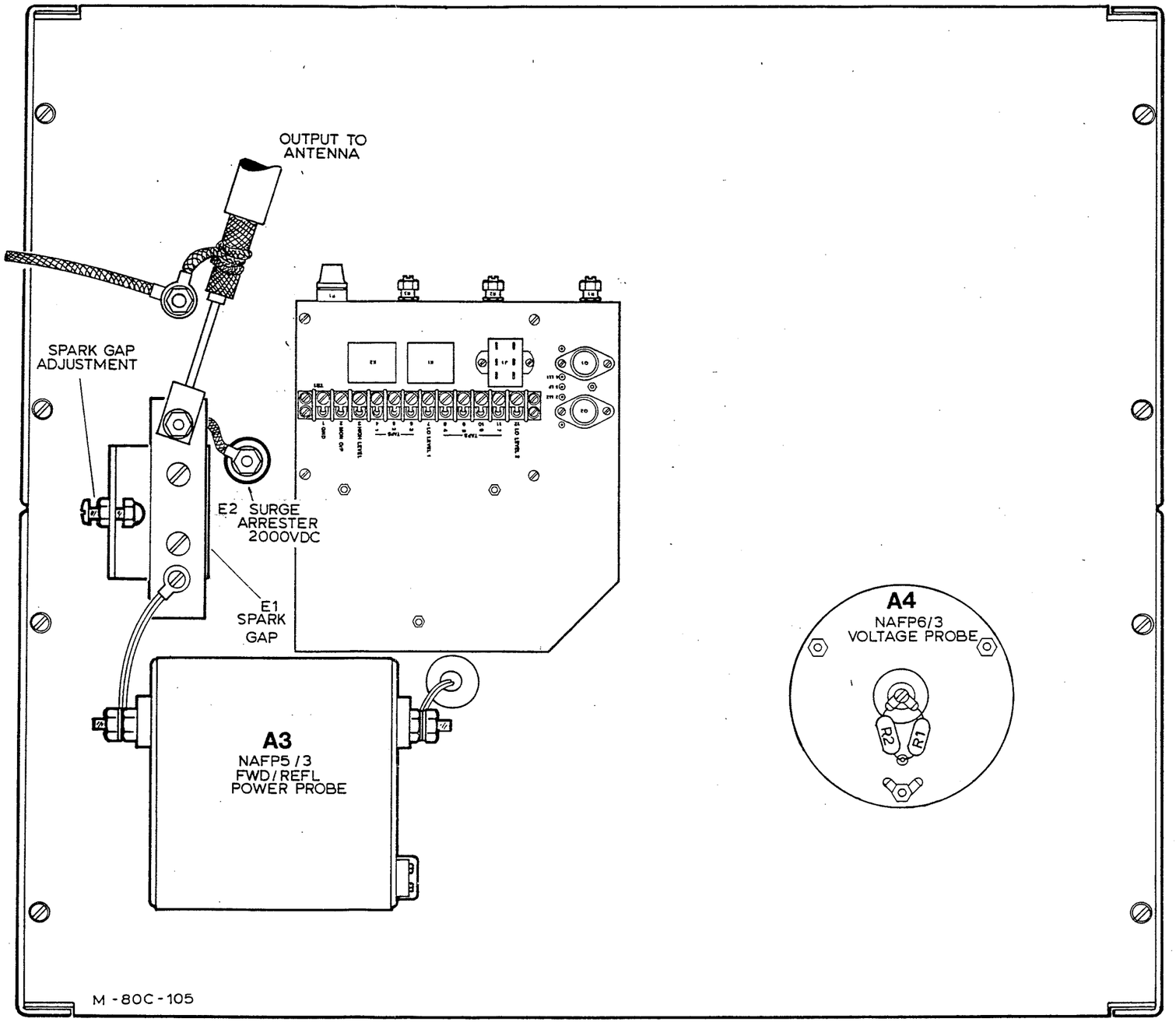

Figure 4 NAF33 Harmonic Filter showing location of NAFP15 Modulation Monitor Probe