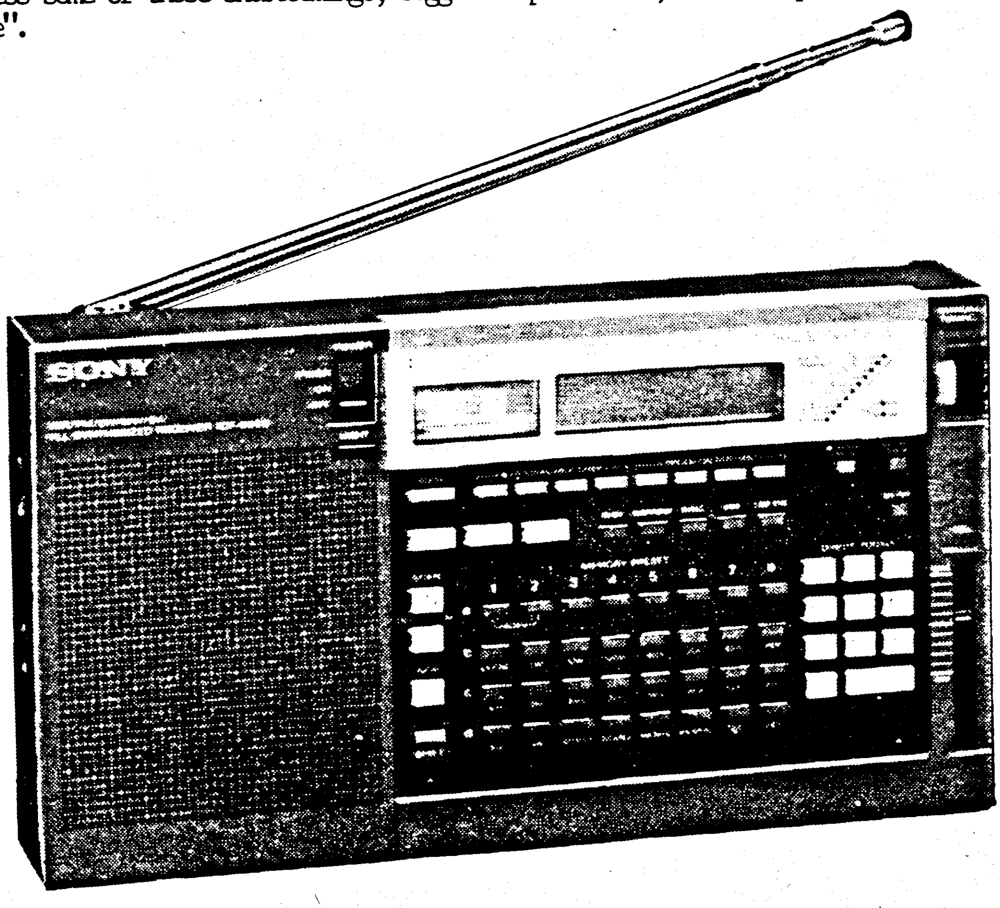
MODIFYING THE SONY ICF-2010/2001D

A Compendium

Gordon Darling

THE ULTIMATE PORTABLE?

When I first started DXing, many more years ago than I care to remember, second hand (usually WW2 surplus) equipment was the order of the day. DXing on holiday or while lazing on the beach was impossible. The equipment was bulky, ran from hefty mains power supplies and had inaccurate analogue frequency readout. In short, it was neither easy to use nor portable. However in the seventies things began to change for the better. This "change" was the gradual availability of reasonably portable receivers and, if not digital, at least accurate analogue frequency readout. The Barlow-Wadley XCR-30 (released 1972) and the SONY ICF-5900W (1979) are obvious examples of this first generation of quality portables. The next development was the affordable, true digital-readout portable receiver the SONY ICF-2001. Since then other manufacturers have followed SONY's lead, some with notably less success than others. Late in 1984 SONY released the ICF-2001D (or ICF-2010 in the US market). In some respects this portable was a quantum leap ahead in consumer technology with its synchronous detection and other advanced features. Even now, six years after its release, the ICF-2001D has very little competition. Not even Grundig's Satellit 500 is threatening SONY's niche in the market. With minimal competition from rival manufacturers SONY has virtually no incentive to bring out a replacement and both SONY Australia and SONY Japan deny a replacement for the ICF-2001D is in the pipeline. So, we are stuck at least for the immediate future with the ICF-2001D as THE portable of choice for serious SWL or DX use. Despite its reputation as the best in its class the ICF-2001D has many shortcomings. This article hopes to address some of those shortcomings, suggest improvements, and attempt to attain the "ultimate portable".



IMPROVEMENT AREAS

In order to provide the most useful information in an easily useable form it was decided to break the modifications/improvements to the ICF-2001D down into sections. These fall into the natural categories of Audio stage, Antenna/RF stages, IF/Mixer/Selectivity stages, power supply, and miscellaneous hints. However, a **WARNING** before proceeding. SONY used a mix of discrete components, SMT and LSI components on double sided printed circuit boards in the construction of this receiver. IF YOU DON'T KNOW WHAT YOU ARE DOING DON'T EVEN TRY. Having said that, many of the following tips/hints require little tecnical knowledge. But don't attempt any modification if you are not sure of your abilities, and bear in mind that many of the modifications will void your warranty. For a large number of the modifications detailed below access to the full SONY service manual is essential, SONY part # 9-951-647-12 including update # 51-647-91.

POWER SUPPLY

The logical place to start with any portable is the power supply section and SONY's battery arrangements for the ICF-2001D have certainly attracted criticism.

a). The memory batteries are a major bone of contention because of the tendency of the receiver to arbitarily wipe the memories, clock and timer at moments of most inconvenience. The problem arises from the standards against which batteries are constructed. The IEC specification for R6 batteries does not specify physical size in absolute terms but in terms of maximum and minimum limits as to length, diameter, etc. As a consequence some AA cells (IEC R6) are slightly larger than others. The batteries specified by SONY Eveready # 1015 are, for example, slightly larger in diameter than Mallory cells. Therefore some batteries sit more snugly in the battery compartment than other brands. The problem of memory loss is caused by movement of the batteries within the compartment causing noise on the memory supply rail, rather than actual loss of power to the memory components. Now, there are various solutions to the problem as follows;

i) Simplest cure is to wrap tape around the memory batteries to increase their diameter and ensure a tight fit in the battery compartment. Although not a total cure, this technique considerably reduces the number of times that "memory wipe" occurs.

ii) An alternative is to hardwire a LITHIUM memory back-up cell into the memory battery compartment. Bear in mind that normal AA cells (IEC R6) are 1.5 volts each. Lithium cells are nominally around 3 volts per cell so only one battery is required. A suitable lithium cell is the Radiospares AA sized lithium cell which is fitted with solder tags (part # 592-313). Note that Lithium cells, unlike Nickel-Cadmium cells, are not normally rechargeable. Be careful to observe correct polarity when installing the battery. Lithium cells have a very long shelf life and in conditions of low current drain (as in this application) effective life is also very long.

iii) A third possibility is to back up the normal AA memory cells with a high value, low voltage electrolytic capacitor. Finn Ritz Jorgensen in a contribution to DSWCI (Ref 1) indicated he had used a 2200uF 10VDC electrolytic capacitor to provide backup (and some smoothing of the noise on the supply rail) for the AA memory cells. The capacitor must have both leads on the same end (ie: not an axial leaded capacitor). The leads can be extended with thin insulated wire and the electrolytic stuck inside the receiver close to the loudspeaker with "Superglue" or similar. The positive wire is connected to the positive tag on the right hand end of the memory battery compartment. The negative lead goes to the nearest convenient 0V ground land. I have also used a 10,000uF 6VDC electrolytic succesfully and my own ICF-2001D is currently fitted with a one <u>Farad</u> 5.5VDC memory back-up capacitor (Radiospares part # 115-039). This solution has the added advantage that the charge held by the capacitor is sufficient to allow changing of the memory batteries with no loss of the memory contents. With the one Farad electrolytic, the ICF-2001D will run for over ten minutes with the batteries removed before the charge is lost. Similar large value electrolytics are available from Maplin Electronics (see Sources). A one farad 5.5VDC electrolytic (42x32.5x15mm) part # FA25C is available at £5:96. A pcb mounted one Farad electrolytic (8x21.5mm dia) is available as part # JR018 at £3:95.

b) The main 4.5V power supply seems to be less of a problem than the memory back up supply, but some comments are necessary.

i) It should be noted that in a receiver costing close to $400 SONY chose to save 10¢ on a protection diode for the external DC input socket. External power supply reversal will cause the ICF-2001D to suffer severe internal pains of a terminal nature! This is not a problem in most areas as SONY's own power supply is available with the receiver. In the Australian market, because of local energy supply authority regulations, the ICF-2001D is sold without an external power supply. For the benefit of Australian (and New Zealand) SWLs and DXers, there are four versions of two different power supplies available. The appropriate one to order is "Adaptor, AX:AC140W, part # 1-463-633-00".

ii) If you use a power supply other than SONY's you must ensure that the DC input plug to the receiver is negative tip. The easiest way to protect the ICF-2001D is to fit a protection diode across the DC input socket within the receiver. A one amp rated diode, or higher, soldered across the appropriate points on the jack board (see relevant pages in the SONY manual) will provide "crowbar" protection against power supply reversal. Effectively the diode does nothing when a power supply of the correct polarity is connected. However the diode presents a dead short circuit to a reversed power supply. This might not do the power supply any good at all but it will protect the ICF-2001D!

iii) SONY's own power supply for the ICF-2001D is not regulated and in fact the receiver will happily run on 5.5 volts or higher without damage despite the nominal 4.5 volt requirement. I have run my own ICF-2001D with no problems from a solar panel which provides a nominal regulated 6 volt (in fact nearer 5.8 volts). The solar panel used is a flexible unit that looks rather like a four ring binder. When unfolded it measures 13 1/2 x 9 5/8" and is less than 3/8" thick. The unit comes with a small regulator and provides a regulated 6, 9 or 12V at up to 400mA in full sunlight. Even with half the unit covered it still powers the ICF-2001D quite happily. The unit is extremely useful for DXing on the beach or at a poolside barbecue for those who live in sunny climes and wish to save on battery costs. The unit is a "Sun Pal 105" and further information can be obtained from Sovonics (see Sources).

iv) The consensus of those I've talked to is that, in normal use, Alkaline D cells (IEC R20) are far more cost effective than ordinary zinc-carbon D cells. On a trip round SE Asia in Dec/Jan 88/89 I used my ICF-2001D heavily on a daily basis through 7 countries over 17 days. The alkaline D cells were fitted new at the beginning of the trip and still lasted for weeks afterwards despite very heavy use. As an alternative you might like to consider Nickel-Cadmium ("Ni-Cad") cells. John Albert (WA9FVP) in Monitoring Times (Ref 2) describes the use of re-chargeable Nicads. The problem with Nicads is that they only produce 1.2V rather than the 1.5V of Zinc-Carbon cells. Three Nicads add up to only 3.6V rather than the 4.5V of Zinc-Carbon cells. The ICF-2001D starts to hiccup and distort at 3.3V approximately which means that the Nicads are working on the limit of their voltage rating. John used two ordinary C cell size Nicads and two Radio Shack "Sub C" size cells. These four cells fit snugly into the main battery compartment (with foam padding) as they are the same overall length as three D cells. John also describes in his article the addition of a charger socket to the ICF-2001D to permit charging the Nicads with a 9V adaptor. Charging can take place overnight or whilst the radio is running of the normal external 4.5V power supply. The parts count for the charger modification is minimal but it does require some cabinet surgery to mount the input socket. I can vouch for the effectiveness of this particular modification. After reading John's article I fitted Nicads and charger input to my own ICF-2001D and have not had to purchase batteries since! John has indicated he can answer enquiries but please enclose return postage and a response may not be immediate due to pressures from other projects. For European owners of the ICF-2001D Maplin Electronics (see Sources) also stock "sub C" style Nicads. These cells are tagged (although the tags can be removed) and are intended for model radio-control purposes. They are 42mm long (C cells are 50mm, D cells are 61mm). So, three D cells are 183mm in length at 4.5V nominal, whereas two x C cells plus two x sub C cells are 184mm long at 4.8V nominal. Part number of these "SC" cells (which is what Maplin call them) is JF98G and cost is £2:45 each.

AUDIO PERFORMANCE

In what amounts to a fairly sophisticated (and expensive) portable, SONY didn't get things right as far as the audio performance. Complaints have surfaced about the ICF-2001D's "muffled audio", audio distortion and low level tape output among others. Certainly SONY hasn't been able to produce a portable in this price range with the kind of audio associated with Grundig products, despite SONY's proven track record in Hi-Fi consumer electronics.

i) The low level output for taping seems to be a common complaint with most SONY AM/FM/SW portables and seems to be a deliberate design ploy. It would appear that the output level and impedance is designed to interface with the microphone input of SONY's portable cassette recorders. Certainly the ICF-2001D's tape output provides a near perfect match to the microphone input on SONY's semi-professional TCM-500EV cassette recorder. Dale Wagner also notes that the tape output works well with the microphone input of a micro-cassette recorder which is possibly the ideal solution for those who have to travel light. If your cassette recorder has only line input facilities reducing the value of R200 (see SONY manual) may help. As supplied, the ICF-2001D tape output produces around 3.5mV into a high impedance (One Megohm) load for a -35dBm, AM signal modulated at 60% with a 1kHz tone. Short circuiting R200 brings this level up to around 30mV. You'll have to experiment with resistor values to find a good input level match to the particular tape recorder you are using. R200 is a very small surface mount resistor on the extreme left hand side of the main board and is accessible without major dismantling of the receiver. Steve Whitt (Ref. 9) suggests reducing R200 to 10 Kilohms from the original 18 Kilohms, and increasing R201 to 2.7 Kilohms from the original 1 Kilohm. R201 is located immediately below R200 on the main PCB and is also a surface mount resistor. Increasing R201 will provide a better impedance match to a cassette recorder line input.

ii) SONY's proprietary synchronous detection IC, the CX-587, is capable of producing AM stereo as well as synchronous detection. John Albert (WA9FVP) in his "Monitoring Times" article (Ref. 2) also describes a modification to provide an AM stereo low level output. Once again this requires "surgery" to add an output socket but may be of interest to ICF-2001D owners in North America and Australia who have local AM stereo stations. The modification works with the Motorola system as used in Australia but I can't comment on the Kahn system which isn't available in my part of the world. Note that the output is very low level and you will need to feed it into a stereo amplifier. John Albert also suggests that the ICF-2001D's internal speaker can be used for one channel while the other sync/stereo channel could be fed to a small mono amplifier and speaker combination. Incidentally, has anyone any information on the synchronous-detection CX-587 IC (eg: a data sheet) with information on signals available (if any) on the unused pins?

iii) Unlike the much cheaper Sangean ATS-803A the ICF2001D does not provide stereo headphone output on FM which is an unfortunate ommission in a receiver of this price. Whether the retrofitting of a FM stereo output is really worthwhile is up to the individual. I have done some experimentation using a National Semiconductors LM 1800 PLL FM Stereo Demodulator (Ref. 3) which requires only a few additional parts (see Diagram One). I'm not sure it is worth the time and effort to develop the idea any further but some SWLs or DXers might be interested in experimentation. Sprague have also recently released a single-chip FM Stereo Decoder (Ref.10) which, once again, requires very little in the way of additional components to produce a functional headphone-level stereo output.

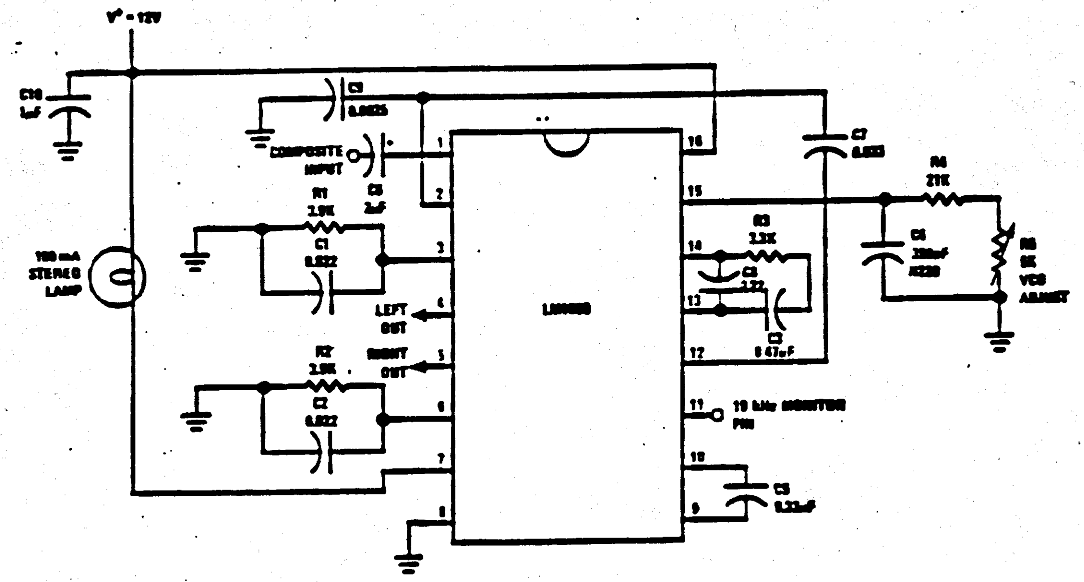


DIAGRAM ONE

iv) SONY provided very comprehensive timer facilities to allow taping of your favourite DX programme, but the ICF-2001D has no facility for remotely switching a tape recorder. This is not a problem for me as my own TCM-500EV cassette recorder has VOX operation capabilities. In addition I don't like leaving a cassette recorder in the record position for long periods of time. If the recorder's pinch wheel is left pressed against the tape capstan it can cause eventual damage to the pinch wheel. So, remote switching is not an area that I have investigated. Others have though, as follows;

A) Current sensing. The circuit in Diagram Two was used by Leo Barr (Ref. 4) for remote switching a cassette recorder with a Sangean ATS-803A. The circuit is designed to sense the voltage drop of a 7.5V (nominal) external power supply when current is drawn. When the ATS-803A switches on the current drawn causes a voltage drop across D1 and D2 switching on TR1, the BC108 transistor then switches the relay (a 5 volt relay in this circuit). This circuit can be modified for use with a SONY external power supply and an appropriately lower voltage Zener diode and relay. Incidentaly, the US equivalent of the BC108 is the 2N3904 or 2N2222. Though as Nick Hall-Patch points outs any small signal NPN transistor will work in this circuit.

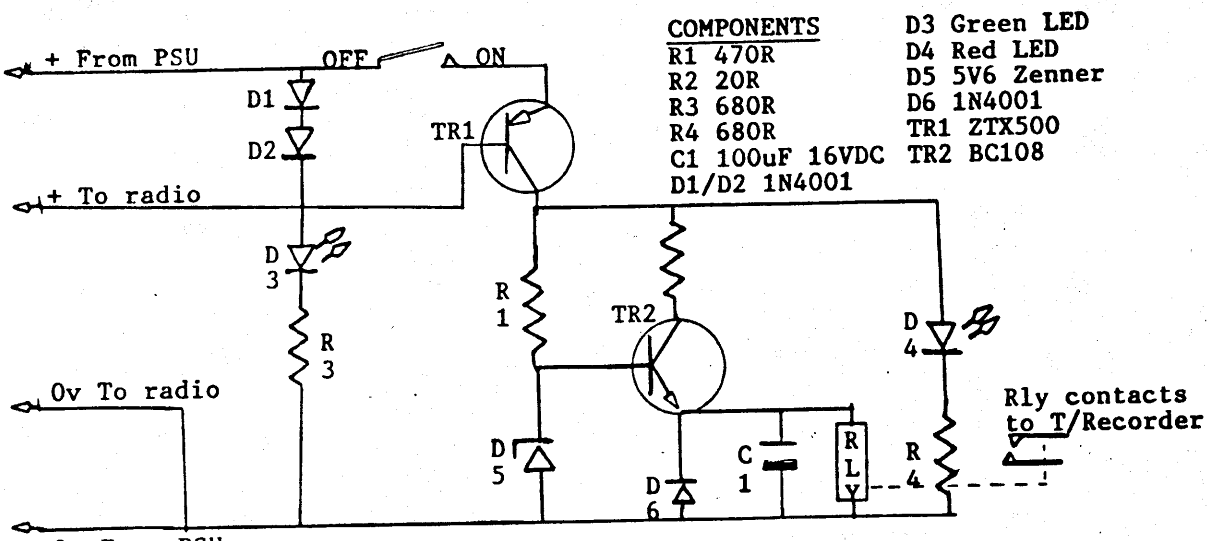


DIAGRAM TWO

B) Direct switching. The circuit used by Michael Laba from New Zealand is probably the simplest form of remote tape recorder control possible for the ICF-2001D. The only components required are a reed switch, a coil and plugs/leads for connections. Michael constructed a coil round the reed switch by "pile" winding approximately 150 turns of 35 swg enamelled copper wire on the middle of the reed switch, which gave a nominal DC resistance for the coil of 3 Ohms. The coil is connected in series with the ICF-2001D's external power supply. When the ICF-2001D's timer switches on the current through the coil (and the magnetic field so produced) is sufficient to operate the reed relay contacts. The reed relay contacts are then used to switch the tape recorder. The unit Michael built was mounted inside a small 40Om x 30mm x 15mm plastic box with the necessary wander leads and a plug to feed the ICF-2001D's DC input socket. The unit has worked succesfully for three years with no problems. Sometimes the simplest ideas are the best! Michael makes the point that this circuit should only be used to switch low DC voltages and NOT mains current. Leo Barr (item A above) also makes the point in his article that many cassette recorders, when switched to standby, only disconnect the cassette motor and not the rest of the recorder's electronics. Leaving your cassette recorder on standby for hours to record DX in the middle of the night may drain the batteries even though the cassette motor is not running.

C) The easiest approach of all. For those who dislike soldering irons, the simplest way is to buy it pre-fabricated. Saul Berger of Soltronic, formerly the Solar Light Co., manufactures a cassette controller called the CC 2020. The cost is around $37:50 and Soltronics address is listed in the Sources list at the end of this article. The principle, which seems to be current sensing, is similar to above ideas in terms of the connections required. The information in Diagram 3 should be self explanatory. Saul advises that CC 2020 can also be used with Sangean and Panasonic radios.

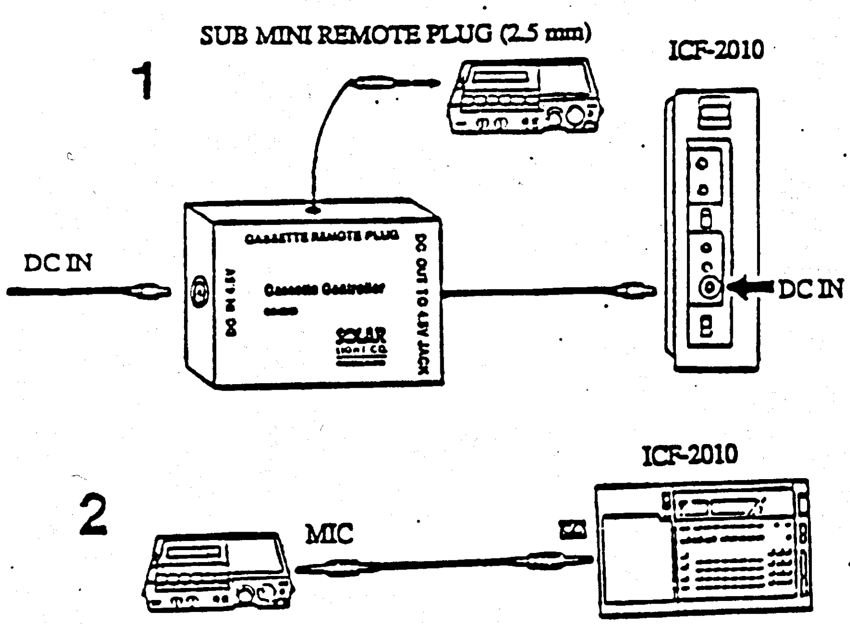


DIAGRAM THREE

v) Now, a look at the headphones output. The headphone output socket on the ICF-2001D is a stereo socket but wired for mono. As such it can be used with either stereo Walkman style headphones or with mono headphones. Bill Babb commented, that since he uses headphones almost exclusively, the headphone socket tended to come adrift from the printed circuit board. Hairline cracks manifested themselves along the solder holding the socket to the board. The socket is easily accessible on the jack board when the rear cover is removed. It's an easy job to resolder the socket. In the January 1989 issue of "Monitoring Times" a contributor, Doug

Darius, suggested bypassing the limiting resistor(s) to provide sufficient level to drive an external speaker such as the Grove SP100 "Sound Enhancer". These two resistors are marked as R301 and R302 on the SONY circuit diagram. One is wired in each leg of the stereo socket and are 47 Ohms each. These two are surface mount components easily accesible on the jack board of the ICF-2001D when the rear cover is removed.

vi) Finally, the overall question of the ICF-2001D's audio "quality". One further alternative is to bypass the SONY audio stages completely. A solution would be the Kiwa Electronics Multiband AM Pickup (MAP) which picks up a receiver's IF signal (as long as its 455kHz) and provides full synchronous detection and audio processing facilities. The unit is available for around $340 (plus post & packing) from Kiwa Electronics, 9815 61st South, Seattle, WA 98118, Phone (207) 722-KIWA. For an excellent review of this unit I would recommend the article by Guy Atkins in the 1989 edition of Fine Tuning's Proceedings.

ANTENNA & RF STAGES

There are a number of problems with the antenna input arrangements on the ICF-2001D and also with the RF stages.

i) Firstly a word of warning for those contemplating buying an ICF-2001D from an overseas duty-free source. There are effectively five different versions of the 2010/2001D. The standard familiar version appears as either the ICF-2001D or the ICF-2010, has full uninterrupted coverage from 150-29,999.9kHz, full FM coverage from 76-108MHz, provides airband coverage and is fitted with USB/LSB selection. Some models, with the same model numbers, are supplied with permutations of the following. No airband coverage, no USB/LSB switching, restricted 87.5-108MHz FM coverage, a gap in coverage at 285-530kHz, or coverage ending at 26,100kHz on AM. If you buy overseas be cautious and ask questions. That is no consolation for those stuck with a restricted coverage receiver because of local regulations as in Germany, France or the Middle East. Fortunately it is relatively easy to restore some of the missing coverage. There are four links on the keyboard printed circuit, associated with diodes D511 and D512, which inhibit the signal lines from the encoder IC. These links inhibit four seperate functions. 1) Coverage from 285-530kHz, 2) Coverage of the Airband, 3) Coverage from 76-87.5MHz, and Coverage from 26,100-29,999.9kHz. All that is required to restore full FM coverage or full AM coverage is to remove the appropriate solder links. The links are not easily accessible and careful dismantling of the receiver is required. If you have a restricted coverage version of the ICF-2001D it's probably well worth the effort though. Restoration of the AIR band is probably not economical as the selection switch is missing from these versions along with a couple of dozen components. From the SONY manual it would seem that in some versions of the receiver everything is installed for USB/LSB switching except the push buttons on the front panel - the keyboard matrix is the same for all versions. For those willing to try surgery it should be possible to dismantle the receiver, drill holes in the appropriate positions, and use a matchstick or similar to operate the USB/LSB switches on the keyboard matrix. Currently the cheapest sources of duty-free ICF-2001Ds are (in cheapest first order) Dubai or Abu Dhabi airport shops (under US $280 at Abu Dhabi); Amsterdam's Schipol airport; Tsim Sha Tsui in Hong Kong; and the People's Park in Singapore. For travellers in the Southern Hemisphere the Australian duty-free outlets in Brisbane and Melbourne are fairly good value (but you don't get the power supply with the receiver).

ii) The original version of the ICF-2001 had no protection in front of the first RF transistor. SONY learnt the lesson and later serial numbers of the ICF-2001 had protection diodes fitted to the input of the first RF stage (a 2SK107 JFET). That lesson was also transferred to the design of the ICF-2001D. Protective double diodes D304 and D305 are connected between the telescopic antenna and the first RF stage. BUT, when an external antenna is plugged in to the ICF-2001D's external antenna socket these diodes are removed from circuit! Assuming you use SONY's nifty little antenna connectors the solution is simple. Diodes exhibit a "knee voltage" before which they will not conduct. So, back to back diodes will not affect the weak RF signal you are trying to hear but will short circuit static pulses which could damage the 2SK152 front-end JFET. My own solution, and that of Richard Gordon, is to install protection diodes inside the little plastic antenna box that SONY supplies with each receiver. Richard only used two diodes whereas I used four in series/parallel to reduce possible cross-modulation problems. Both Richard and I used 1N914 diodes but virtually any small-signal diode would do. For North American owners of the ICF-2001D Richard quotes the Radio Shack part number for the 1N914 as #276-1122 and cost as 10 for $0.99. Both the two and four diode solution are shown in Diagram Four.

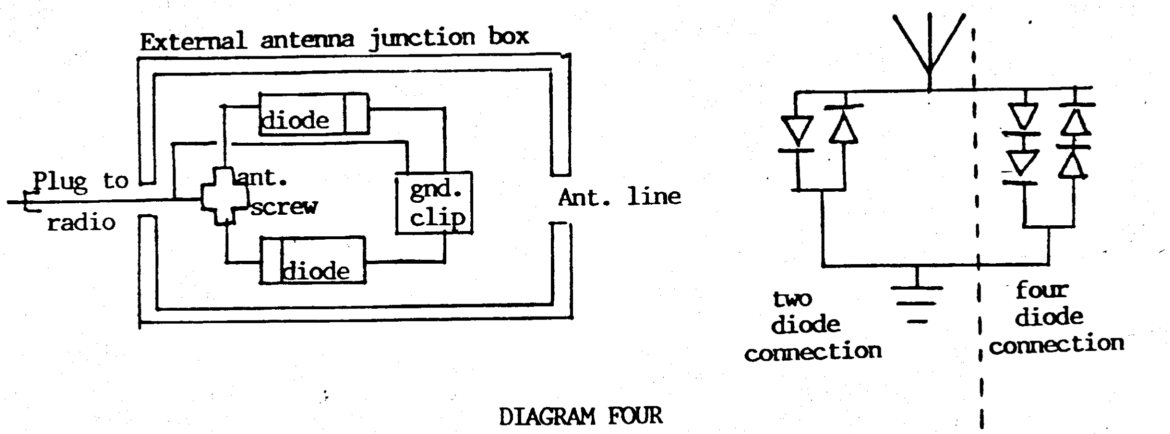


DIAGRAM FOUR

iii) OK, so you didn't have any protection and you had a beverage antenna connected during thunderstorm. What do you do if you have prematurely terminated the life of the input JFET? Luckily Q303 is easily accessible as it is located on the jack board and not the main PCB. However, be very careful when working on this board as it is very easy to break the thin wires going to the ferrite rod antenna. The 2SK152 is not too hard to come by and SONY will supply it. The problem with substitution is the low supply rail used by SONY in this receiver. The rail voltage of 3 volts severely limits any choice of replacement. Finn Ritz Jorgensen says he ended up using a dual-gate MOSFET (a 40673). By connecting gate 2 directly to the drain of the device he ended up with a three terminal MOSFET with far better input protection than the stock 2SK152. The 40673 has worked so well that Finn says he never bothered to install the 2SK152 he got from SONY later. Guy Atkins used a Motorola MPF102 JFET as a substitute. As Guy notes the MPF102 is available virtually worlwide. From Motorola's data sheets I would say that the MFP102 is working virtually on the lower limit of its drain/source voltage curve with a 3 volt rail but Guy says it works just as well as the 2SK152 and seems to be less static sensitive. Other substitutes/equivalents recommended have been the ECG312, J304 and 2N5951.

iv) Front end overload. The ICF-2001D has a less than spectacular dynamic range when compared with a receiver like the R71A, the NRD525 or the R5000 but it does cost a lot less. The ICF-2001D, like any portable, is designed to provide adequate sensitivity with its built in antennas. Also, unlike the original ICF-2001, SONY's current offering has no bandpass filtering in the front end. All RF signals from DC to daylight appear at the gate of the front end JFET on the 150-29,999.9kHz range (the Airband does have bandpass filtering). On top of all this SONY chose to place selectable attenuation in probably the worst place possible. The RF gain control is virtually useless at preventing cross-modulation since it is located after the pair of 2SK152s comprising the first mixer stage (Q1 & Q2). Any overdriven mixer is inherently non-linear and cross-modulation is inevitable if these transistors are faced with high unwanted RF levels. The DX/Local switch is more effective but it still comes after Q303 (that front end

JFET again!). If you wish to use an external antenna then either limit yourself to SONY's supplied length of antenna wire (even this is too long for RF alleys like Western Europe) or use attenuation and passive preselection between the antenna and the receiver. Note, I said passive. Many of the available makes of active antenna will give the ICF-2001D severe RF indigestion. There are at least two possible exceptions to this. I have used succesfully a Datong AD270 indoor active antenna but with a stepped attenuator between the AD270 and the ICF-2001D. Guy Atkins and myself have also used a very nifty active antenna called the AC-1 micromodule antenna from Inline Components (see Sources). This antenna works very well with the ICF-2001D as it does not have excessive gain. In addition it is indeed "micro" in size and is ideal for the travelling DXer who has to travel light. The unit comes with a "sucker" like hook to hang the antenna from your hotel bedroom and a ferrite rod coupler is available for BCB/MW listening. Wes Olsen of Inline Components is very helpful and he suggests that anyone interested in the AC-1 contact him for details. Costs are $31:00 for the AC-1, $58:00 for the AD-2 AC/DC portable version, and $15:00 for the ferrite antenna coupler. Prices are exclusive of shipping charges. However, the caveat still applies. With the ICF-2001D, be very wary of connecting large or active antennas capable of producing high RF levels into the front end of the receiver. Cross-modulation is inevitable in anything but a very quiet RF environment and there are few of those places left! The SONY active antenna, AN-1, seems to have been designed with the ICF-2001D's (and other SONY receivers) shortcomings in mind and has very low overall gain to the point of insensitivity.

v) Connection of BCB/MW antennas to the ICF-2001D is another problem. When an external antenna is plugged into the AM antenna jack on the receiver all of the LW/MW circuitry is disconnected. This includes the ferrite rod antenna, the 2SK152 RF amplifier (Q302), and the 2SC2785 AGC stage (Q301), and in any case the ICF-2001D circuitry is deliberately desensitised below 2MHz as part of SONY's design philophosy. This, in fact, works well when a tuned loop antenna is used but creates problems when a random wire is used. I have only done a little experimentation in this area so any input and ideas would be welcome. Enrico Oliva has used a "magic disc" frame antenna. This is produced by Deutschelandfunk (see Sources) and is the size of an LP record. It is supplied fixed-tuned to DLF's channel. Enrico substituted a variable 365pf capacitor to make the unit tuneable. With the ICF-2001D mounted inside a wooden support frame, and the "magic disc" on top, a marked improvement in BCB/MW reception is noted. From Enrico's notes and sketch, coupling between the ICF-2001D and the "magic disc" is inductive. Enrico says that the "Magic disc" is sent free of charge by DLF to European listeners who experience difficulty in receiving DLF's transmissions. The device is costly to produce and obtaining one might be difficult if you live outside Europe. Fritz Mellberg also notes that Radio West in California (see Sources) produce a simple tuneable ferrite rod antenna which will inductively couple with the ICF-2001D and improve BCB/MW reception. Enrico Oliva also detailed his cure for overload and spurious signals from his 30 metre longwire antenna. Inside SONY's antenna terminal box he mounted a 0.01 uF capacitor in series with the antenna and a 41 Ohm resistor from the braid of the incoming co-axial cable to the tip connection of the lead to the ICF-2001D's antenna input socket. Finding the right combination of capacitor/resistor will require some juggling to match your own antenna set up.

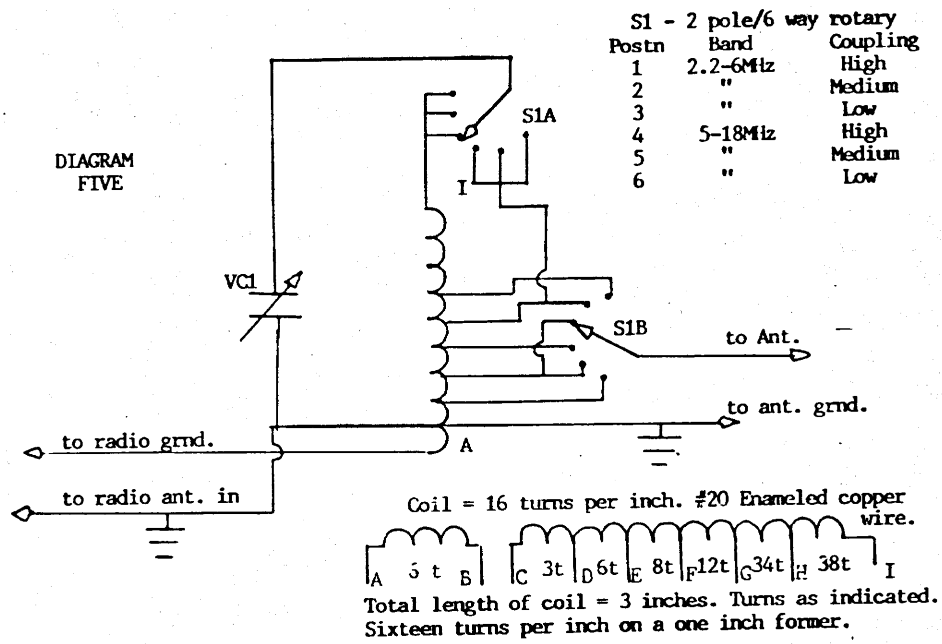
vi) Steve Whitt (Ref. 9) suggests a novel method of restoring the lack of sensitivity below 2MHz. If the 3.5mm antenna plug is not fully pushed into the antenna socket on the ICF-2001D, but only just inserted, the input filter which causes the desensitisation is bypassed. However, once again beware of front end overload.

vii) Beverage antennas. If you want to try a beverage with the ICF-2001D (assuming you have fitted protection diodes in the antenna connector!) Steve Whitt describes an interesting matching unit. The unit uses a 365pf or 500pf variable capacitor and switched inductors ranginging in values from 6.8 to 470 uH. These are stock values so coil winding is not required.

viii) Finn Ritz Jorgensen uses a magnetic loop with coverage from 9 to 30MHz (down to 5.5MHz with added capacitance) which cures the front end selectivity problems on Finn's ICF-2001D. The loop consists of a 70cm diameter loop of 50 Ohm co-axial cable. The cable used is high quality with a solid (not braid) outer screen. A 7-150pf variable capacitor is mounted on a "Tee" piece of perspex at the top of the loop for tuning. The co-axial cable is 16mm flexible co-ax with the outer insulation stripped off. A 37cm loop of insulated hook-up wire is soldered between the outer and inner cores of the co-ax at the base of the loop and the pickup feed to the ICF-2001D is taken from this point. Further information on loop antennas for portable receivers is available in Ref. 12.

ix) As noted in iv) the easiest method to get around cross-mod problems with the ICF-2001D's front end is to use passive preselection. Steve Whitt describes a passive preselector in his series of articles (Ref 5. & 9). John Tow has suggested the circuit in Diagram Five.

DIAGRAM FIVE



This passive preselector covers 2.2 to 18MHz in two switched ranges. The tuning capacitor allows the circuit to be peaked to resonance in conjunction with the tap on the coil. John housed his unit in a plastic case with a metal lid on which the tuning capacitor was mounted. He used a stock coil but a similar coil cab be wound on a piece of PVC tube with # 20 SWG enamelled copper wire. The variable capacitor is a standard variable (around 365 to 500 pf maximum capacitance). Don't use the minature style used in modern transistor portables - the minimum capacitance is too great. For those who prefer not to "homebrew", MFJ manufacture a ready-built passive preselector (# MFJ-956) costing US $37:95 which is available from Universal Shortwave (see Sources).

x) Finally Dale Wagner points out that if you are using an odd length of wire as a random "longwire" you only need a 3.5mm jack plug. The antenna needs to be connected to the tip of the plug only. An easy way of connecting an antenna quickly when you're out in the bush.

SELECTIVITY

Much has been written about the selectivity of the ICF-2001D. Selectivity however is a two sided coin. Selectivity can be measured in completely objective terms specifying parameters such as 3 or 6db bandwidth, 60db bandwidth, passband ripple, etc. But selectivity is also subjective. Depending on your interests (and your hearing!) what is too wide a filter for your purposes may be too narrow for someone elses. SONY compromised just as any other designer has to do when producing consumer electronics. SONY had to juggle cost, physical size to fit on a cramped PCB, good audio response on strong local stations on BCB/MW, and reasonable selectivity on fading, weak shortwave signals. All this in a mass-market portable. Whether SONY got the balance right is very much a matter for individual judgement. Those that have been dissatisfied have tackled the task of effecting a "better" choice of bandwidths. Diagram six shows SONY's IF filtering arrangements for the ICF-2001D.

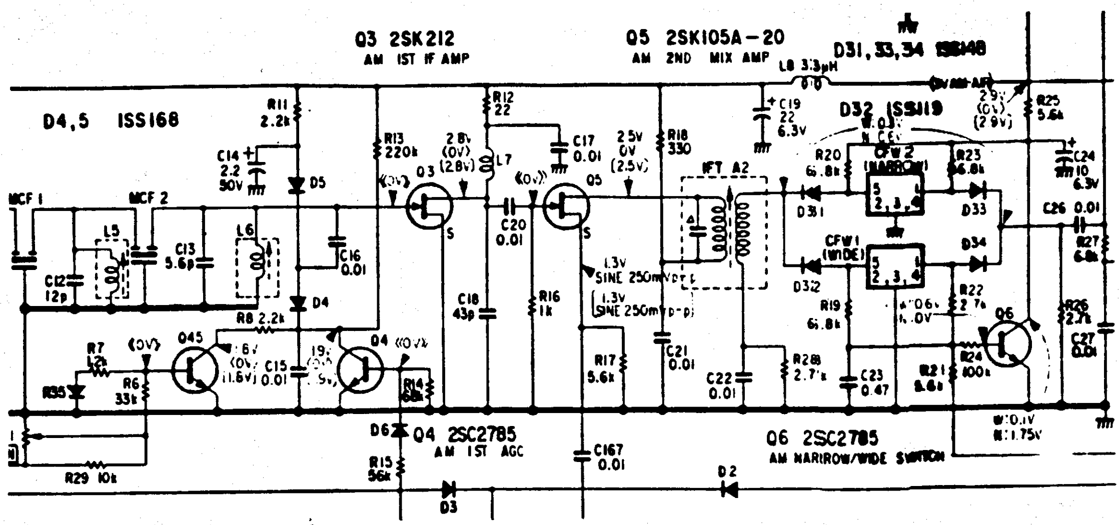


DIAGRAM SIX

The two filters marked MCF 1 and 2 are first IF roofing filters. The actual IF selectivity is provided by the filters marked CFW 1 (wide) and CFW 2 (narrow). These filters are nominally (at -6 db) 11kHz wide and 4.4kHz narrow. Changing them for either narrower filters or filters with a better shape factor is tricky for two reasons. The filters are mounted on the very densely crowded main board. Components are flow soldered to both sides of the board in the vicinity of the filters and care is required when removing and replacing the original filters. Secondly, because of the limited space, any replacement filters need to be the same physical size and to be pin compatible. The existing filters are made by Murata and are part # CFW455G (wide) and CFW455JT (narrow). A number of retailers of replacement filters can be found in Sources.

i) Steve Whitt, in an excellent and highly recommended series of articles on the 2001D (Ref. 5) replaced only one filter. Steve used a filter from Radio West (see Sources) to replace the narrow filter and then used the original narrow filter to replace the wide filter. This resulted in measured -6db bandwidths of 2.95kHz narrow and 4.2kHz wide. Steve also points out that as the filter in the wide position is used for Airband this modification results in an improvement in selectivity for this band as well.

ii) Finn Ritz Jorgensen (Ref. 1) went one stage further and replaced both filters. The AM wide ceramic filter was replaced by a CFG455G and the narrow filter by a CFG455J. Both these are Murata components and the CFG filters have a markedly better shape factor than the CFW filters. However, the CFG filters are not direct pin compatible, drop in, replacements, although they are the same physical size as the originals. You'll need a magnifying glass and a pair of tweezers to bend the filter's pins to the right angle. Finn chose those filters to give an acceptable level of fidelity in the narrow selectivity position. Murata's specifications for these filters are - CFG455G 8.0/20.0kHz bandwidth at 6/60db, CFG455J 3.0/9.0kHz bandwidth at 6/60db (although Finn quotes 9.13/13.6kHz and 5.2/7.5kHz respectively). These filters (and the full range of CFW, CFU and CFG Murata filters) are available from Bonex in the UK (see Sources). However I've been unable to locate a US source who will supply in small quantities.

iii) John Albert in his 'Monitoring Times" article (Ref. 2) describes improving the selectivity of his ICF-2001D by using an ICOM FL30 filter. It is unclear from John's description just where in the circuit he used the FL30. In addition, this is a fairly large filter and John installed it by taping it inside the receiver and extending it to the appropriate points on the PCB with six inch shielded wires. This isn't a modification I'd recommend because stray capacitance from the shielded wires will severely degrade the ultimate stop band figures of the filter. John's article though is a very interesting source of ideas for the ICF-2001D.

iv) In my own case the filters I used were as follows. A CFW455HT was used to replace the wide filter. This is a pin compatible drop-in replacement and is 6kHz wide at 6db down and 18kHz wide at 60db down so it still retains a reasonable bandwidth for "easy listening". Incidentally the Murata filters with the additional letter T in the type number have a better shape factor and ultimate stop band than filters of the same series without the letter T. The narrow filter I replaced with a CFJ455K 2.4kHz SSB filter (I happened to have one handy). This filter is physically larger than the existing filters but was small enough for me to mount on stiff wire within millimetres of the PCB. The improvement in selectivity in the narrow position is nothing short of astounding making copy of Trans Pacific BCB/MW "splits" far easier than on a stock ICF-2001D. The wide filter is still wide enough for normal listening but gets rid of annoying 5kHz hetrodynes noticeable on an unmodified ICF-2001D.

v) Lastly on 455kHz filters. If you are shopping around for replacement filters here are the relevant specifications for the two existing filters. Input and output impedance 2000 Ohms; insertion loss 6db; physical size 11mm long, 7mm wide, 6.5mm high. The bandwidths specified in Murata's literature are CFW455G ± 4.5kHz at -6db and ± 10kHz at -50db; CFW455JT ±3Khz at -6db and ± 5kHz at -50db.

vi) The IF bandwidth of the ICF-2001D on VHF/FM is fairly wide, at least 300kHz wide at 6db down. This is fine for stereo but if you have no intention of experimenting with stereo decoders then an improvement is possible. A narrower bandwidth will give better adjacent channel rejection for FM DXing. The appropriate 10.7MHz IF filters are marked as CF1 and CF2 on the ICF-2001D's circuit diagram. These are identical units. Replacement provides a minor problem because of the method by which ceramic filters are manufactured. The manufacturing process produces a wide spread of centre frequencies even though the centre frequency is supposedly 10.7 MHz. Murata's ceramic filters, for example, are produced in batches which are then colour coded according to approximate centre frequency. Black, blue, red, orange and white spots on the filter refer to nominal centre frequencies of 10.64, 10.67, 10.70, 10.73 and 10.76 MHz respectively. It is essential that the two replacement filters are a matched pair. Although zero offset from 10.7 MHz is ideal, in practice the precise offset from the 10.7 MHz nominal centre frequency is not that critical as long as both filters have identical offsets. The FM IF filters in the ICF-2001D are the industry-wide standard minature units with 3 pins in line. The existing filters are Murata SFE 10.7 MA. Murata quotes a 280 kHz bandwidth at -3db and 650 kHz at -20db with an insertion loss of 6db. An ideal FM filter would be 150 kHz wide with steep sides to accomodate normal FM broadcast deviation of ±75 kHz. Steve Whitt (Ref. 9) suggests replacement of the existing filters with Murata SFE 10.7 MJ filters. These have a quoted -3db bandwidth of 150 kHz and a -20db bandwidth of 400 kHz which is a big improvement. However, these filters have a 10db insertion loss. Replacing both filters will give a hefty additional 8db loss through the ICF-2001D's IF on top of the fact that the receiver is not particulary sensitive anyway. In my own case I used Murata SFE 10.7 MS3L filters which have a slightly wider -3db bandwidth of 180 kHz but an insertion loss of only 3.5db. These filters are so cheap (60 pence each in the UK) that experimentation isn't going to break the bank. Basically, any replacement filter needs to have an insertion loss of 6db or less, a bandwidth of around 180 kHz and an input/output impedance close to 330 Ohms. The two filters are located on the ICF2001D's main PCB and are easier to replace than the AM filters. Bonex in the UK (see Sources) stock a full range of of Murata ceramic filters. It should be noted, however, that the ICF2001D is never going to make a hot-shot FM DX machine. Its sensitivity is fairly poor though this can be helped with the use of a loft/attic or outdoor antenna and a preamplifier. BUT, as well as being deaf the ICF-2001D is very prone to image problems on the 88-108MHz band. This manifests itself by stations being heard on their nominal frequency and also at twice the IF frequency below the correct frequency. Eg: a strong station on 100.3 MHz can also be heard at 78.9 MHz (100.3 MHz - 2 x 10.7 MHz). A high gain antenna will only make this problem worse.

MISCELLANEOUS TIPS AND HINTS

In addition to the areas covered above a miscellany of points were raised by those who responded to my original letter. So, in no particular order;

i) Nigel Reid notes that the airport X ray machines in the USA consisently wiped the memories/clock, etc. Apparently by resetting the microprocessor.

ii) Bill Babb notes that despite the "coarse" 100 Hz tuning steps he had no difficulty in copying RTTY. Bill uses an E.T.I. 730 demodulator driving a Siemens Model 100 teleprinter.

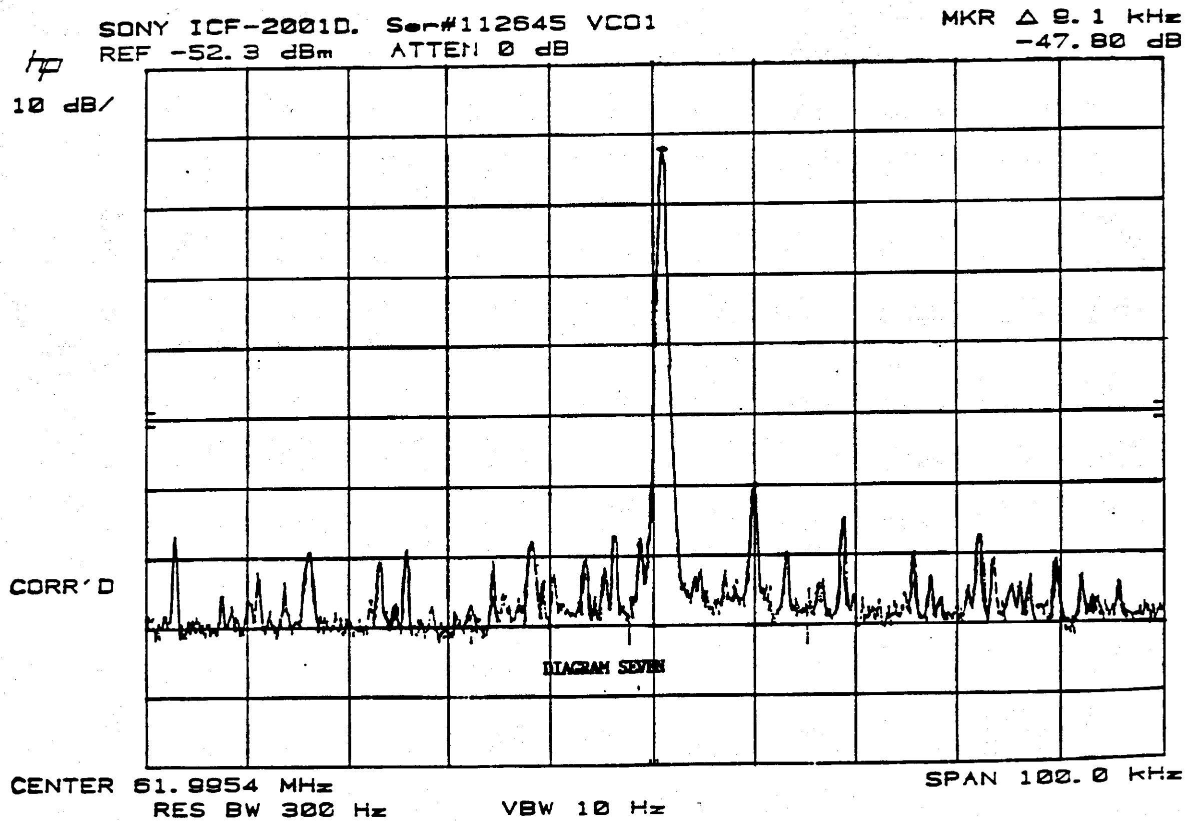
iii) Punch-up errors. Bill Flynn comments that erroneous entries can be cleared immediately by hitting the "AM" key which returns the previous frequency entered (or FM or AIR as appropriate).

iv) Enrico Oliva notes that the ICF-2001D has no squelch control as such but the squelch circuit, utilised during scanning, can be used. If monitoring a single channel, enter it into a memory channel and "skip" all others and use "memory scan". The automatic squelch level works well, particularly on Air band.

FURTHER POSSIBILITIES

It is doubtful that we have approached the concept of the ultimate portable. Even when a receiver with the performance of an NRD-525 becomes available in a package the size of a cigarette pack there will still be widely varying views as to what constitutes the "ultimate". Hopefully some of the above modifications will help you to improve your ICF-2001D and bring it nearer to your idea of a perfect portable. But what of further experimentation? Lets take a look at some possibilities.

i) The ICF-2001D suffers from pronounced phase noise and reciprocal mixing (Ref. 6). Steve Whitt (Ref. 5) investigated this area in his series of articles. In particular he looked at the poor performance of the receiver's oscillators. Steve's receiver appears, from photographs taken from a spectrum analyser display and shown in his series of articles, to have had worse problems than my own ICF-2001D. Nonetheless, spurious products from the first oscillator (VCO1) in my receiver are clearly visible with the worst at only 48db down in Diagram Seven. Any unsuppressed spurious outputs from either VCO1 or VCO2 will produce unwanted mixing products. All of which are bad news. Steve details modifications to "clean up" the output of the local oscillators. The modification is "fiddly" rather than difficult to a accomplish. It involves the removal of the shield plate over the oscillator circuits on the main PCB and the addition of three sub-miniature ceramic capacitors. I can vouch for the effectiveness of this modification as it reduced all spurious outputs from VCO1 to below the noise floor on my own ICF-2001D. On word of warning on this mod though. On one ICF-2001D (Ser # 44512) a side effect of the modification was to produce severe instability when the receiver was tuned closed to the final IF frequency of 455 kHz. If these symptoms appear try juggling with the exact positioning of the capacitors and make sure that <u>all</u> of the tags on the shield plate have been resoldered to the appropriate ground land.



Incidentally, Steve collated all the information in Short Wave Magazine articles into a booklet called "Getting the best from your SONY ICF-2001D" which is available directly from Steve at 21 Cauldwell Avenue, Ipswich, IP4 4EB, United Kingdom. Cost is £4:00 in the UK, £5:00 or 13 IRCs airmail to Europe and surface mail for the rest of the world; and £6:00 or 13 IRCs airmail worldwide. The booklet contains information and further research which was not included in the original series of articles.

ii) Steve also suggests modifications to the "S" meter circuit in the ICF-2001D to give a more rational relationship between received signal level and number of LEDs lit. The modification requires the reduction of R 60 (see SONY manual) till the level of sensitivity required is reached. This is not a modification I have tried but this is a possible area for further experimentation.

iii) The synchronous detector in the ICF-2001D was the best thing since sliced bread when the receiver first appeared, because it was the <u>only</u> synchronous detector available in a consumer portable at the time. However, the years have shown some of the circuit's shortcomings. The ICF-2001D has difficulty in "sync" mode, dealing with SWBC stations using dynamic carrier control. Phase modulated radio data systems as used by some European stations (Ref. 7) such as DLF, BBC and RTF also cause the sync circuit to have heartburn, as do interfering signals less than 50 Hz away from the wanted carrier. Improvements to the performance of the synchronous detector would seem to be a fruitful area for further research and those interested may like to refer to an article by Trevor Brooks (Ref. 8) which describes an advanced synchronous detector. The circuit described provides DSB, LSB, USB, ISB/Stereo spread, and Quadrature outputs.

iv) The ICF-2001D's AGC circuit tends to "pump" on SSB signals because of the time constants chosen by SONY. John Albert (Ref. 2) also investigated modifying the AGC with the addition of a two transistor circuit to give a fast attack, slow decay AGC time constant for SSB reception.

v) An obvious area for further improvement is the audio quality from the ICF-2001D. Suggestions have included picking up the detected audio before the output IC, feeding it through a pre-amp/graphic equaliser combination and thence to a seperate amplifier. Unfortunately the ICF-2001D then ceases to be a portable! Any suggestions for a suitable replacement for the LA 4146 audio amplifier IC used in the receiver?

vi) The ICF-2001D has no integral noise limiter. An interesting IC has recently been released by Sprague (Ref. 11). This is a complete noise blanker on a chip. The IC is available in 16 or 18 pin, DIL or SMT packages and the external parts count required is minimal. The chip acts a true noise blanker in the IF/RF audio chain rather than just as a noise clipper. The 16 pin version is single channel, whereas the 18 pin version is dual channel for AM stereo receivers. Apparently the IC is only currently available in development quantities but it might be a fruitful area for research when more widely available.

CREDITS AND THANKS

Finally, my grateful thanks to those who answered my open letter. Without their input this article would have had a lot less information. In no particular order they were Steve Whitt (UK), Guy Atkins (USA), Finn Ritz Jorgensen (Denmark), Richard Gordon (USA), Bill Babb (Australia), Bill Flynn (USA), Dale Wagner (USA), Michael Laba (New Zealand), Saul Berger (USA), Nigel Reid (UK), Enrico Oliva (Italy) and John Tow (USA). This project took me far longer than anticipated. Nonetheless I've enjoyed reading everyone's contributions and trying to get them all together into this article. Any feedback would be very much appreciated.

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18) INTERBOOKS. Lynton, Stanley, Perth PH1 4QQ. Tel: (44) 738 828575. (European source for Ref. 6)
19) UNIVERSAL SHORTWAVE RADIO. 1280 Aida Drive, Reynoldsburg, OH 43068, U.S.A. Tel:- (1) 614 866 4267. (MFJ Passive pre-selector)