BY DOUG DeMAW, W1FB

QRN Squasher Upgrades

The W1FB QRN Squasher MK-II that appeared in June 1996 issue of *CQ* stimulated more interest than I anticipated. Equipment manufacturers and scores of amateurs contacted me about the circuit. In the course of communicating with people who had built and were using the MK-II unit, I gathered ideas that inspired the development of the MK-III Squasher described here

Some Problems Reported

I received scattered reports of overloading caused by nearby commercial AM broadcast stations. I confess to a blind spot: The nearest BC station to this location in northwest lower Michigan is some 28 miles distant A high-pass filter for correcting the problem is described in this article. The filter may be added to the earlier MK-II unit simply by cutting a PC board conductor and inserting the filter at that location (see fig. 1).

Some builders chose to use separate switches for the DC power and the bypass functions. This caused damage to the output transistor in the Squasher when transmitting if the power ON/OFF switch was in the OFF position, thereby preventing the T-R relay, K1, from cycling. The MK-III version has "back-door" protection for those times when the user has cockpit trouble. A 1/10 amp fuse protects the output components of the circuit. A 50 mA pilot lamp may be substituted for the fuse.

Circuit Additions

Fig. 2 is the circuit for the MK-III QRN Squasher. Like its brother the MK-II, it will null manmade noise by up to 50 dB. The earlier **Balance** control is eliminated to simplify adjustment. Phasing transformer T3 has been added to replace the function of the old **Balance** control. Now there are but two controls to adjust for obtaining a noise null

Noise amplifier Q4 is new. It permits using a shorter noise antenna. This stage provides 10 dB of gain. The added boost allows the user to carry the **RF Gain** control (R15) at a higher set-

P.O Box 250, Luther, MI 49656

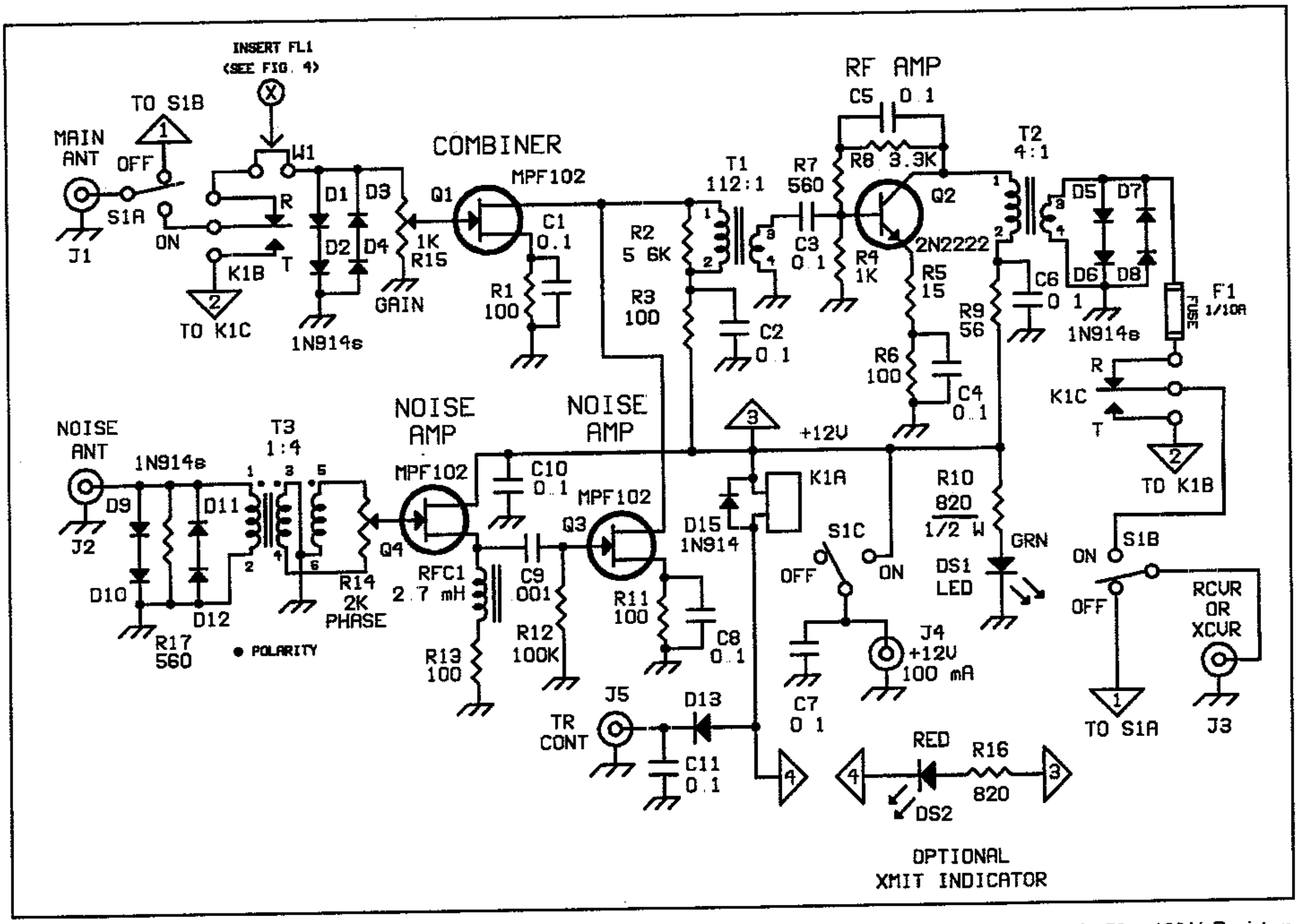
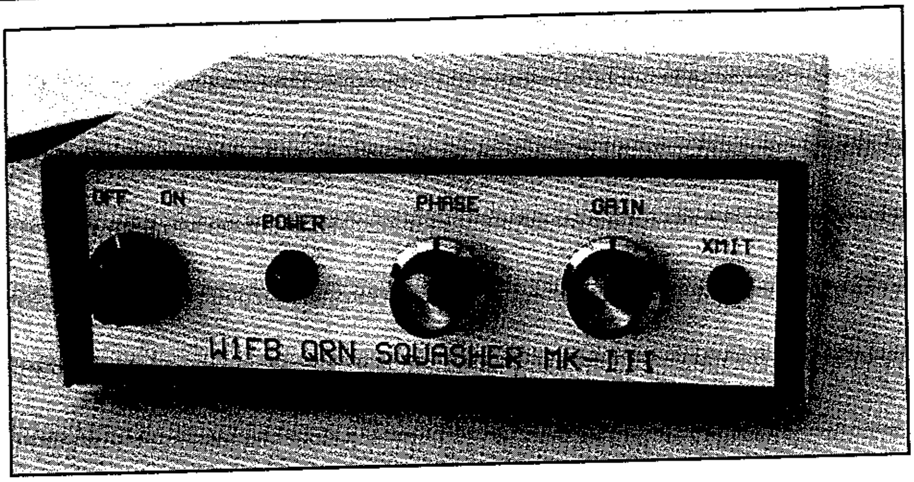


Fig 1– Schematic diagram of the MK-III QRN Squasher. Capacitance is in μF. Capacitors are mini disc or matchhead ceramic, 50 or 100 V. Resistors are 1/4 W carbon unless otherwise indicated. K1 is a DPDT PC-mount 12 VDC, 16-pin DIP relay, Omron No. G5V-2-DC12 (Digi-Key no. Z768-ND).[5] RFC1 is a miniature 2.7 mH RF choke. R14 and R15 are panel-mount, linear-taper carbon controls. S1 is a 3-pole, 3-position rotary wafer switch (1 position not used), Mouser No. 10WW033. T1 has 30 turns of No. 28 enam. wire on an Amidon FT-37-43 ferrite toroid (850 μ_i). Secondary has 10 turns of No. 28 enam. wire. T2 has 16 primary turns of No. 28 enam. wire on an Amidon FT-37-43 toroid. Use 8 turns of No. 28 for the secondary winding. T3 has 16 trifilar turns of No 28 enam. wire on an Amidon FT-50-43 toroid (observe polarity). W1 is a jumper wire.



The W1FB QRN Squasher MK-III.

ting. This results in greater overall circuit gain at the noise null.

Q2 has been changed from a source-follower JFET to a class A fed-back bipolar transistor amplifier. This modification provides a signal increase of 5 dB over the MK-II version.

A second LED indicator has been added (DS2). This is optional for those who wish to illuminate a red LED during **Transmit**. This feature tells the operator that relay K1 is switching properly.

Some Noise-Canceller History

Two *CQ* readers wrote letters in which they mentioned early-day noise-cancelling techniques that might be of interest to the readers. Fig. 2 shows how a passive noise reducer circuit was configured in the early days of radio. This circuit appeared in an old edition of the *Radio Handbook* which was edited by Frank Jones, W6AJF. The difficulty encountered with this circuit was its critical adjustment. All three variable capacitors needed to be juggled until a noise null occurred. Furthermore, as is true of all passive circuits with their inherent losses, there was moderate attenuation of the desired signal. Also, the LC circuits had to be tailored for each band of operation. Conversely, modern noise cancellers are broadband devices that are not lossy. They require no tuned circuits.

Circuits similar to that in fig. 2 were used in some WW II military receivers for the purpose of removing ignition noise during mobile operation. A two- or three-turn center-tapped link was wound over the grounded end of the receiver tuned circuit input coil and connected to the tuning capacitors as shown in fig. 2. Separate links were required for each band of operation, thereby making the circuit awkward to install and manipulate.

Theory of Operation

Most RF energy can be cancelled if the amplitude of the two energies is equal and of opposite phase (180 degree shift). Passive and active QRN eliminators operate on this principle. The desired signal, along with local man-made noise of a specific phase and amplitude, arrives at J1 of fig. 1. Noise and the desired signal arrive also via J2 from the short noise antenna. Energy from the noise antenna is amplified by Q3 and Q4 after the desired phase reversal is secured by means of **Phase** control R14.

Noise of equal amplitude (set by R15) and opposite phase (R14) is combined in the drain circuits of Q1 and Q3 to provide cancellation. The resultant "laundered" signal is amplified 15 dB by Q2, then routed to the receiver via J3.

The question has been asked, "Why isn't the desired signal cancelled, too?" This was explained in the June 1996 *CQ* article, but some amateurs took me to task on the Internet and claimed my information was incorrect and my circuit could not and would not work. It is my understanding that none of the critics built and tested the MK-II Squasher. They merely were

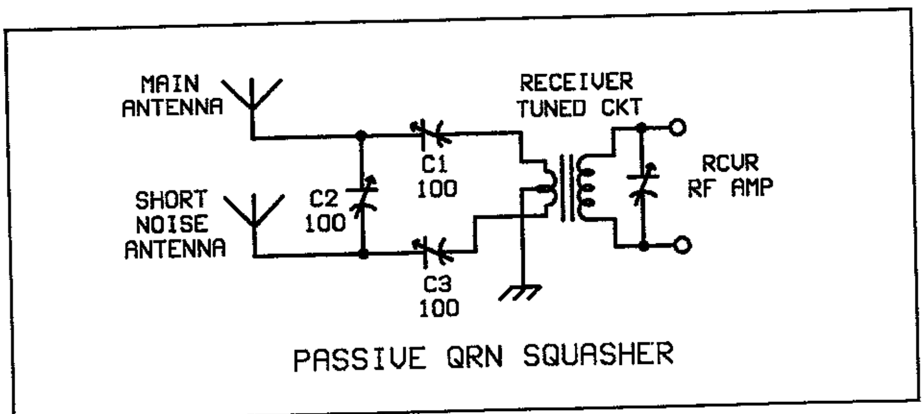


Fig. 2– Circuit for an early-day L-C noise-cancelling network for use ahead of a receiver.

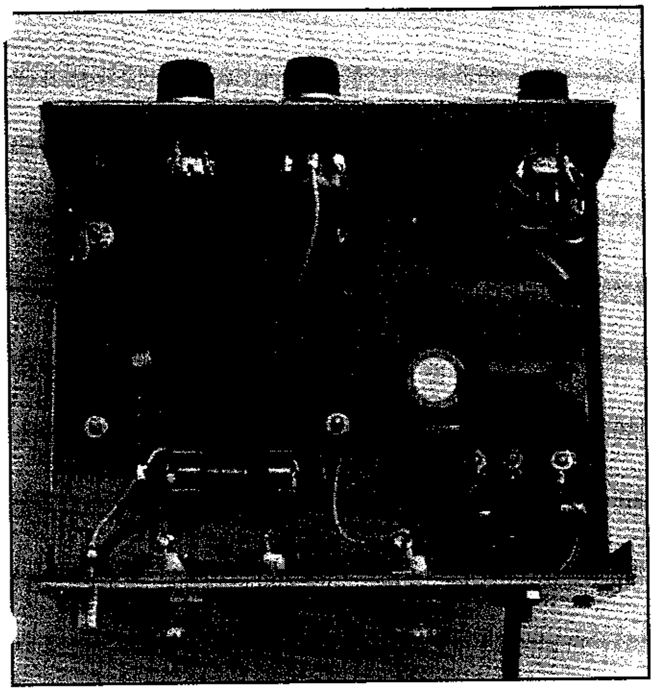
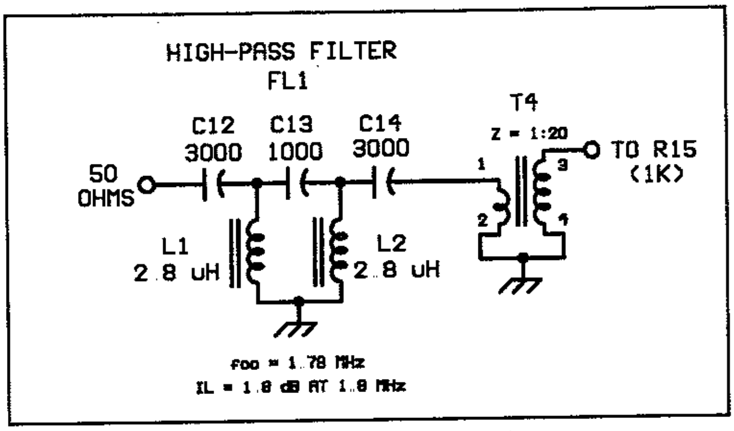


Fig. 3– Interior view of the MK-III QRN Squasher. A regulated +12 V, 100 mA power supply is used in this model.

Fig. 4– Circuit for a high-pass filter that can be inserted at "X" in fig. 1 to eliminate overloading from AM broadcast signals. C12, C13, and C14 are polystyrene or silver-mica capacitors (or combinations thereof to obtain the required values). L1 and L2 (2.7 µH) have 30 turns of No. 28 enam. wire on Amidon T37-6 (yellow) powdered-iron toroids. Keep all leads short. T4 secondary has 16 turns of No. 28 enam. wire on an Amidon FT-37-43 toroid. Use 4 turns of No. 28 wire for the primary winding.



engaging in "Monday morning engineering."

The desired signal energy is not cancelled, because it arrives from both antennas with a changing phase and amplitude. Signals refracted from the sky are constantly undergoing phase, polarity, and amplitude changes. Therefore, they are not affected by a circuit that requires constant energy amplitude and phase. Local noise generally remains at the same amplitude and phase, which makes nulling a simple matter without significant attenuation of the desired signals. However, ground-wave signals with constant amplitude and phase can be nulled with the fig. 1 circuit. TV birdies (15 750 kHz horizontal oscillator harmonics) can also be cancelled with the Squasher.

High-Pass Filter

A 5-element Butterworth high-pass filter is shown in fig. 4. It attenuates signals below 1.75 MHz to prevent overloading of the Squasher from strong BC-band signals. Those who live in urban areas may find it necessary to add FL1 at the point marked "X" in fig. 1. Do not use FL1 if it is not needed. Install a jumper wire (W1) across the PC-board terminals provided for FL1. T4 is included to effect an impedance match between a 50 ohm antenna and the 1K ohm resistive load presented by R15. Although it is not essential to ensure a matched condition without FL1, the filter requires a proper termination in order to perform as designed. If you are a perfectionist, you may wish to include T4 at point "X" of fig. 1 even if you do not include FL1. A slight improvement in overall gain can be expected if this is done.

High Q capacitors of close tolerance are required for FL1. Polystyrene or silver-mica capacitors are recommended for C12, C13, and C14. No. 6 (yellow) powdered-iron toroid cores should be used for L1 and L2 to ensure high Q.

Construction Data

Various VHF JFETs are suitable at Q1, Q3, and Q4 of fig. 1. Devices such as the J310 or the 2N4416 are high-quality transistors that may be used in place of MPF102s. The 2N4416s are top-grade FETs. These have excellent pinch-off characteristics and high g_m. Dual-gate MOSFETs, such as the 40673 or 3N211, can be used if the gates are joined to form a single-gate FET.

A circuit board for this project is available.[1] It is arranged for a DPDT 16-pin DIP relay (see fig. 5 for relay details). If you lay out your own PC board, you may use any DPDT 12 volt DC relay, such as those sold by Radio Shack.

It is important to keep the leads between R14 and the PC board as short as practicable. This helps ensure that the desired 180-degree phase shift can be obtained. Furthermore, excessive lead length between the board and R14 and R15 may cause the FETs to self-oscillate. This can produce unwanted wide-band noise that will mask weak signals. R17 in fig. 1 provides a load which prevents Q4 from self-oscillating and creating wide-band noise. Without R17 the short noise antenna exhibits an unwanted high impedance at the input of T3.

Fig. 3 shows the interior of the MK-III Squasher. I included a small 12 VDC power supply for convenience of operation. The 120 VAC primary of the power supply is switched on and off by S1C of fig. 1. A 0.5 amp fuse is used in one leg of the 120 VAC line. A 12 VDC, 100 mA wall transformer may be used to power the Squasher.

I created a computer-generated, paste-on cover for the front panel by means WordPerfect 6.0. A scale pattern is provided in fig. 6. A similar layout can be made in WordPerfect 5.1 if you have a computer. Create a figure box with a thick border and then add the labels. The pattern is transferred to white posterboard with a photocopy machine, sprayed with two coatings

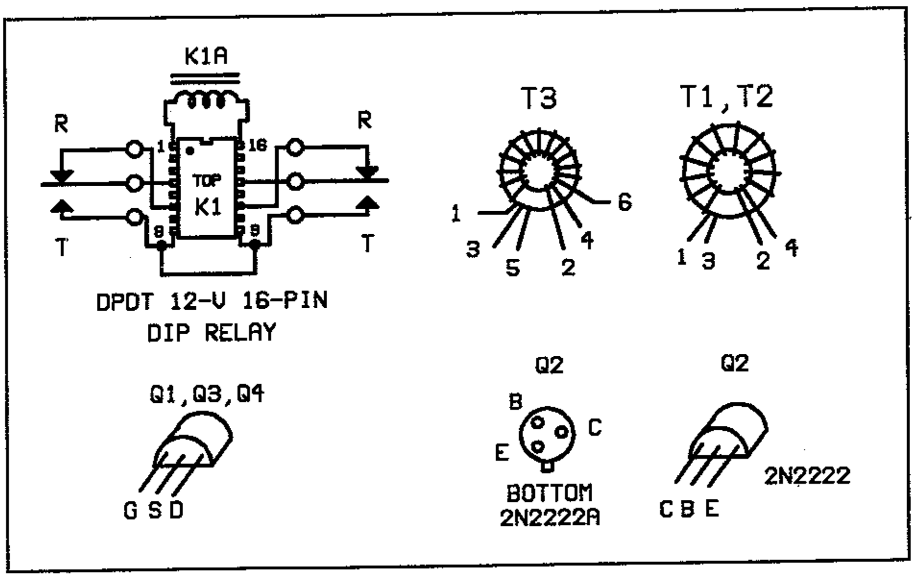


Fig. 5– Pinout information for K1 and the transformers used in the fig. 1 circuit.

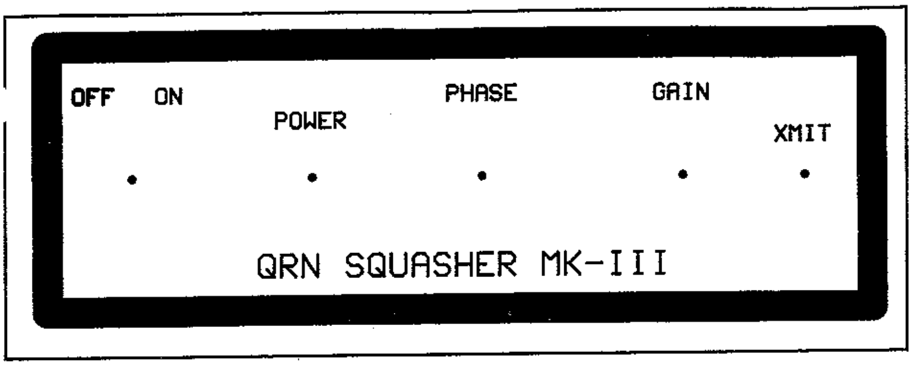
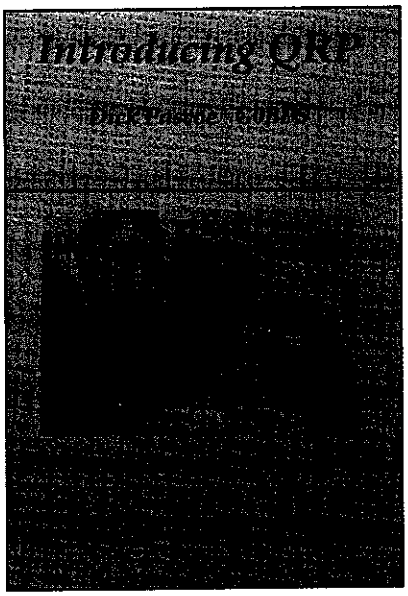


Fig. 6–Scale template for the paste-on front panel.

of clear lacquer, and then pasted on the front panel of the enclosure with contact cement. You can use the fig 6 pattern if you make your project box from sections of PC board. I used a computer A/B switch box that I bought for $1.00 at a hamfest.

RG-174 miniature 50 ohm coax cable is used for all RF wiring between S1, the rear-panel RF jacks, and the PC board. Ground the shield braids of the cables at each end. This will minimize unwanted signal leakage between the input and output ports of the Squasher.

The large green LED (DS1) seen at the left of the front-panel view is a 3/8 inch diameter unit



Introducing QRP, *by Dick Pascoe, GØBPS, presents an introduction to the history and skills of low-power operating in the United Kingdom. Since QRP operating is no different in the U.K. than it is elsewhere in the world, this is a book that should appeal to low-power operators the world over.*

Introducing QRP

By Dick Pascoe, GØBPS

The growing popularity of low-power (QRP) operation has spawned another book on this subject. The latest entry comes from the United Kingdom. *Introducing QRP* is the first book of its kind to originate in England. It was written by well-known QRPer Dick Pascoe, GØBPS, who operates Kanga Products in the U.K. Dick's theme is an introduction to the history and skills of low-power operating in the United Kingdom. He stresses that "power is no substitute for operating skill." It is worth noting that low-power operating in the U.K. is no different than elswehere in the world. Therefore, the book should appeal to QRPers worldwide.

There are ten chapters in the book, including What is QRP?, History of QRP in the U.K., Typical QRP Equipment, Station Accessories, Operating Skills, and Construction Techniques, plus Simple Receivers, Simple Transmitters, and Computers in the Shack. Two appendices treat the Q codes in use today and QRP clubs around the world.

The author takes the neophyte by the hand and walks him or her through the subject of QRP. Experienced QRPers should find the book a delightful reading experience for obtaining the Brits' slant on low-power operation.

Dick includes an overview of QRP clubs in the U.K. and elsewhere in the world. QRP ARCI (Amateur Radio Club International) in the USA is discussed, along with the G-QRP Club of England, of which I am a member. The Rev. George Dobbs, G3RJV, is a principal in the G-QRP Club. He is known worldwide for his editorship of the G-QRP journal, *SPRAT*, and for his technical contributions to the low-power art.

There is a discussion of modest but effective antennas for QRP operation. A simple, practical receiver is described (The Sudden Receiver). It uses two ICs for the complete circuit. Two inexpensive, easy-to-build CW transmitters (The OXO and ONER) are detailed in the book. These projects can be built and made operational by almost any beginner, regardless of his or her previous workbench experience.

There are 74 pages of information in this soft-cover booklet. It measures 6" × 8¼" and is printed on quality white paper. There are eight full-page photo of worldwide QRP notables.

Books may be purchased in the USA from Bill Kelsey, N8ET, 3521 Spring Lake Drive, Findlay, OH 45840. E-mail to <Kanga@mail.bright.net>. The author may be reached at <dick@kanga.demon.co.uk>. Book price: $10, plus $3 shipping.

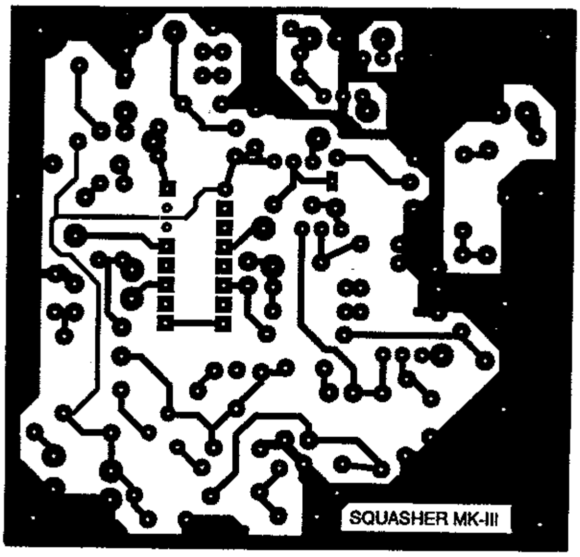


Fig. 7– Scale etching pattern for the MK-III Squasher as viewed from the etched side

I purchased from Hosfelt Electronics.[2] A smaller green LED of the type used at DS2 (far right in photo) is also suitable.

Protective fuse F1, seen in the fig. 3 interior view, is mounted near the PC board in a chassis-mount fuse holder. Two insulating terminals may be substituted for the fuse holder if you carefully solder the fuse to them.

When looking at the interior view, you will observe that the dropping resistors for the two LEDs are outboard from the PC board. This results from using a preliminary prototype board that did not include the resistors. R10 and R16 are included on the final version of the MK-III PC board.

The likelihood of damage from transmitting

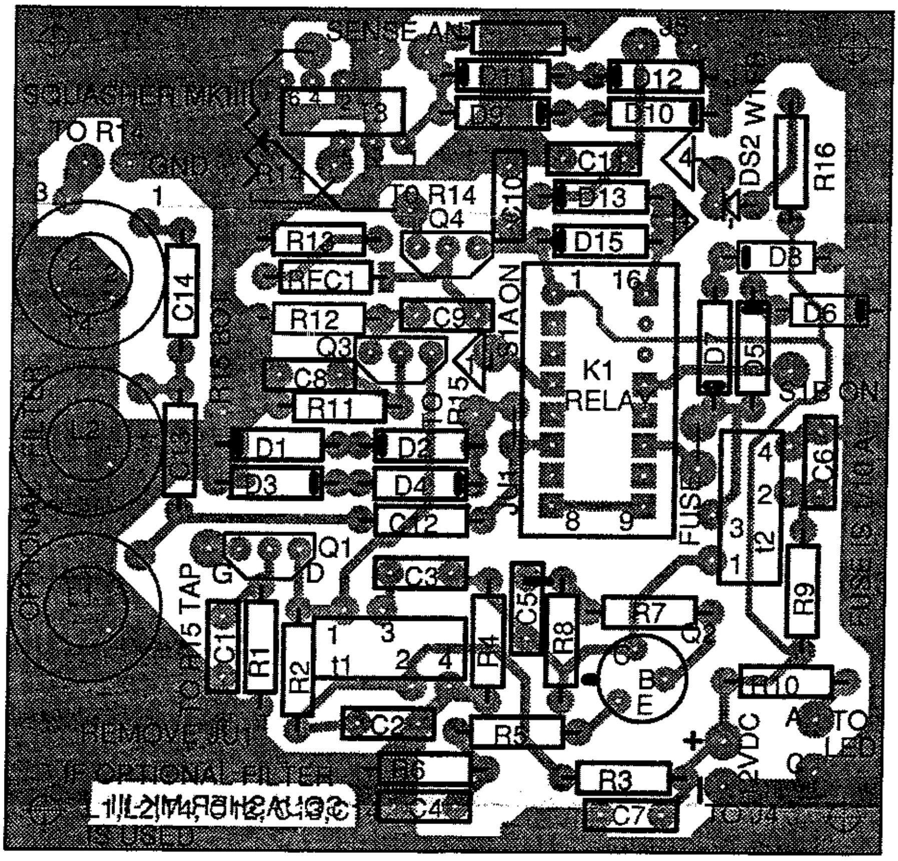


Fig 8– Parts-placement guide for the MK-III Squasher as seen from the component side

into the MK-III Squasher rear end can be avoided by using a 3-P, 2-position wafer switch at S1. These switches can be purchased from Mouser Electronics for a modest price.[3] The toroid cores for this project are available by mail.[4]

A scale etching pattern is provided in fig. 7. A parts-placement guide is shown in fig. 8.

Adjusting The Squasher

Some of those who constructed the MK-II Squasher reported difficulty in adjusting the controls for minimum noise without degrading the desired signal. The easiest method for adjustment is to turn the **Gain** control to minimum, then adjust R14 of fig. 1 for a noise null. Next, advance **Gain** control R15 until the noise is heard weakly. Readjust the **Phase** control for a null. Repeat these steps until a point is reached where the **Phase** control no longer reduces the noise energy. For the earlier MK-II version, the **Phase, Balance,** and **Gain** controls should be adjusted alternately in the same fashion.

The length of the noise antenna must be greater at 1.8 and 3.5 MHz than for the upper part of the HF spectrum in order to sample sufficient noise. A wire length of 30 feet seems to be a good compromise for 1.8 through 30 MHz at my QTH. My noise antenna is parallel to the power lines (100 foot distance) and 4 feet above ground in a horizontal format. You should experiment with the length, polarity, and location of your noise antenna for best results. Sampling the noise from your AC power line by means of a toroidal pickup transformer and routing the energy to J2 of fig. 1 may eliminate the need for an external noise antenna. Power-line noise sampling was used successfully for noise cancellers in the past.

Installation

The Squasher is inserted between the 50 ohm station antenna and the receiver or transceiver. If you use a linear amplifier, you may install the Squasher between the transceiver and the amplifier. The relay control line for the transmitter and linear amplifier must be connected to J5 (TR Control) of fig. 1. This actuates K1 to permit switching around the Squasher during transmit. *Note:* Relay failure will cause fuse F1 to blow, thereby protecting the Squasher. The MK-III unit will safely accommodate up to 100 watts of RF power during transmit.

Summary Remarks

It is important to realize that this QRN Squasher and similar devices are not effective for reducing atmospheric noise such as static crashes. They will work, however, for eliminating corona static from an antenna. Also, the Squasher can null only one noise energy at a given time. Manmade noise from additional sources will still be heard. I have been asked if two Squashers in series would be effective when two noise sources exist. In theory, yes. I have not tried that technique.

There are times when the Squasher causes a slight reduction in signal strength at the noise null. Generally, this does not exceed one S unit. Conversely, depending upon the type of noise present, there is a signal gain of up to one S unit when using the Squasher.

I have been asked if this circuit can be used at 146 MHz. Design changes would be required for effective VHF operation. The bypass and coupling capacitors, and the broadband transformer cores, would have to be changed from the fig. 1 values. Shorter and wider connecting leads and PC board conductors would be mandatory toward ensuring circuit balance and overall gain. The MK-II and MK-III models are effective from 500 kHz to 50 MHz.

Footnotes

1. FAR Circuits, 18N640 Field Court, Dundee, IL 60118. Phone 847-836-9148 to order. Price: $4.25 plus $1.50 s&h.

2. Hosfelt Electronics, 2700 Sunset Blvd., Steubenville, OH 43952. Phone 1-800-524-6464 to order. Catalog available.

3. Mouser Electronics, 2401 Highway 287 N., Mansfield, TX 76063-4827. Phone 1-800-346-6873 to order. Catalog available.

4. Amidon Associates, Inc., 250 Briggs Ave., Costa Mesa, CA 92626. Phone 714-850-4660 to order. Catalog available.

5. Digi-Key Corp., 701 Brooks Ave. S., Thief River Falls, MN 56701-0677. Phone 1-800-344-4539 to order. Catalog available.