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Advanced Receiver Research MML144VDG and MM144VDG Mast-Mounted Preamplifiers and TRS04VD TR Sequencer

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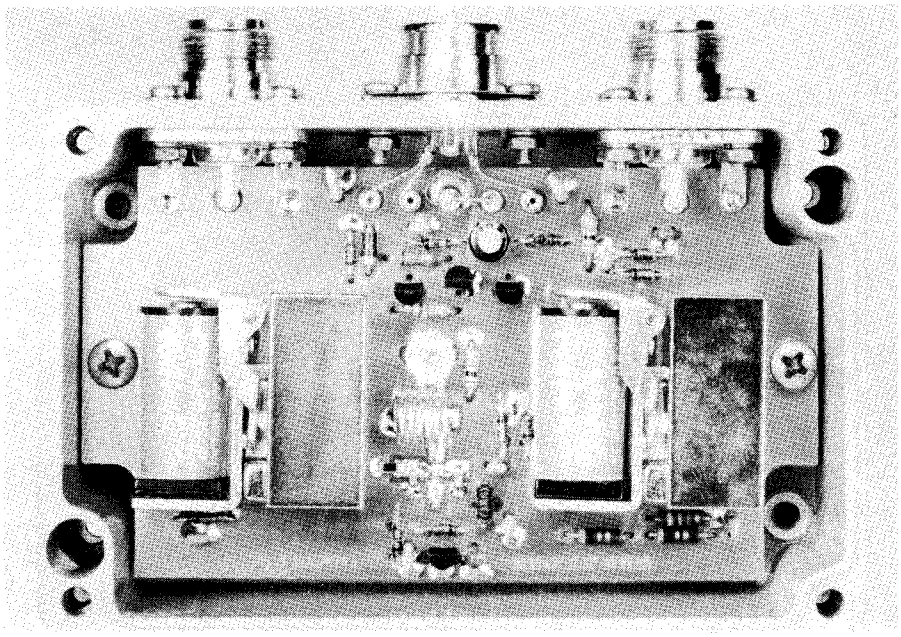
Advanced Receiver Research MML144VDG and MM144VDG Mast-Mounted Preamplifiers and TRS04VD TR Sequencer

Serious VHF and UHF operators have long realized that the best performance can be extracted from a GaAsFET or other low-noise preamplifier only if that preamplifier is mounted at the antenna, ahead of the loss introduced by the feed line. Any loss adds directly to the noise figure of the receiver. While it's possible to operate EME or use OSCAR satellites with the preamplifier located in the station, the lowest noise figure and best results occur when the preamplifier is mounted near the antenna.

Not too long ago, mounting equipment outdoors on the tower was for diehards only. You had to find a suitable low-noise preamplifier and high-quality coaxial relays, come up with a weatherproof mounting system, and design control circuitry to switch everything around. Thanks to Advanced Receiver Research, getting the most from your low-noise receiving system is now as easy as picking up the telephone.

Three separate ARR units are reviewed here. The MML144VDG is a 2-m GaAsFET preamplifier with switching relays that will handle up to 160 W. Its big brother, the MM144VDG, is rated for 1 kW. ARR offers similar preamplifiers for 50, 220 and 432 MHz, as well. The TRS04VD provides sequentially keyed outputs to control the timing of system TR switching to protect the preamplifier and relays from accidental damage. The TRS04VD works with any of the ARR mast-mounted preamplifiers.



MML144VDG Description

The MML144VDG is housed in a rugged diecast aluminum enclosure. A rubber gasket seals the lid so the unit is both RF-tight and weatherproof. Type N female receptacles are provided for connection to transceiver and antenna. A locking DIN receptacle handles the dc connections. All connectors are located on one side of the enclosure, and the unit is installed with this side positioned toward the ground to prevent water from building up around the connectors. An aluminum and stainless-steel clamp assembly secures the enclosure to masts of 1 to 2-1/8 inches OD.

High quality components and construction techniques are evident throughout the MML144VDG. A single PC board holds all the components. A pair of Tohtsu® CX-120P PC-board-mount, RF-type relays dominate the board. The other preamplifier components are located between the relays, with the control circuitry located near the DIN connector.

The preamplifier circuitry is essentially the same as other ARR GaAsFET products. A Mitsubishi MGF-1402 is the active device. The input is tuned with an L network, while the output is matched by a broadband ferrite transformer.

The CX-120P relays are SPDT types. They are connected so that they must be energized to place the preamplifier in the line for receive, and deenergized to bypass it during transmit. There are several advantages to this system. Any time the station is not in use, the preamplifier is switched out of the line to protect it from possible damage from nearby lightning strikes. Also, should the preamplifier break or not be needed, it can be switched off and normal operation can continue as though the transceiver is connected directly to the antenna.

The control circuitry is well thought out, so the MML144VDG is essentially idiot proof. There are three options for keying the unit for transmit. The easiest is automatic RF switching. When the transmitter is keyed, this circuitry senses the presence of RF at the input to the MML144VDG and deenergizes the relays to bypass the preamplifier. It requires at least 5 W at the input to make the unit switch to transmit. This circuitry is similar to the RF-activated switching found in many solid-state VHF and UHF amplifiers. What could be simpler?

If you prefer to have more control over your TR switching, you can provide a command signal from the station to "hard key" the preamplifier. To accommodate the many different rigs on the market, you have the choice of providing a ground-for-transmit or positive-voltage-for-transmit (+5 to 16 V) command. The ARR instructions stress that to prevent preamplifier failures, you must have some type of TR-relay sequencing if you use hard keying. The TRS04VD sequencer described later in this review is ideal for that job.

The control cable from the station has, as a minimum, two conductors for +V dc and ground. A third conductor is necessary if you wish to use either of the hard keying options. The ARR instructions highly recommend the use of shielded cable for the control lead. An unshielded cable can act as an antenna, picking up sufficient induced voltage spikes from nearby lightning strikes to damage the preamplifier.

With low-noise GaAsFET preamplifiers, it is essential to have the right equipment to make meaningful noise-figure measurements. We tested the preamplifiers with a state-of-the-art HP8970A Noise Figure Meter and HP346A Noise Source recently donated to the ARRL Lab by Hewlett Packard. Gain and noise-figure performance for the MML144VDG is summarized in Table 1. With a gain of 22 dB and a noise figure around 0.5 dB, this preamplifier is more than adequate for weak-signal work at 2 meters. Power handling capability is 160 W, so this device is usable with any of the solid-state "brick" amplifiers currently on the market. We tested the review unit with a 150-W Mirage brick without incident.

The review unit was from the initial production run, and there was a minor problem with it. We noticed that low-level harmonics of any 2-meter signal transmitted

Table 1

ARR MML144VDG 2-M GaAsFET Preamplifier

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency range: 144-MHz band, 1-dB bandwidth is 7 MHz.	As specified
Noise Figure: Less than 0.55 dB.	144 MHz, 0.49 dB; 146 MHz, 0.52 dB; 148 MHz, 0.53 dB.
Gain: 22 dB.	144 MHz, 22.25 dB; 146 MHz, 22.01 dB; 148 MHz, 21.76 dB.
Compression point (1 dB): +12 dBm.	+ 5 dBm.
Power requirements: 11 to 16 V dc at 10 mA, max (transmit) and 180 mA max (receive)	At 13 V, 25 mA (transmit), 150 mA (receive).
Power handling (transmit): 160 W.	As specified.
Through-mode SWR: 1.25:1 max.	1.15:1.
Through-mode attenuation: 0.5 dB, max.	0.2 dB.
Minimum power input to activate RF-sensed switching circuitry: 5 W.	3 W
Size: 5-1/2 × 4-7/8 × 3-5/8 in (HWD), including mounting bracket and connectors.	
Weight: 1 lb 13 oz.	

through the unit appeared at the output. These harmonics were not evident when the transceiver was operated without the preamplifier. One of the harmonics was about 55 dB below the amplitude of the fundamental signal. FCC regulations require that, at 2 meters, all harmonics and spurious emissions be 60 dB below the fundamental, or lower. ARR quickly rectified this problem by changing a capacitor in the RF-activated switching circuitry. The problem did not affect operation of the unit in any way, and has been corrected in current production models.

MM144VDG Description

The MM144VDG preamplifier/relay system is definitely for the serious operator. Although it is much simpler in appearance than the MML144VDG, it's an elegant, rugged piece. The switching scheme is similar to the MML144VDG. The relay is a DPDT transfer type that switches the preamplifier in series with a single feed line between station and antenna during receiving periods, and out of the line during transmitting periods. The preamplifier and relay must be energized to receive, so the preamplifier is switched out of the line any time the station is not in use. It may also be left turned off if operation without the preamplifier is desired.

The preamplifier/relay enclosure is a custom-made two-piece affair. The relay and preamplifier are mounted to brackets that are bolted to a piece of 1/8-inch-thick aluminum plate that is bent into an inverted L shape. The mast clamp accommodates pipes of up to 2-inches OD and also mounts to this plate. The preamplifier top cover is made from aluminum sheet. All seams are welded, so there is no entry point for moisture. Four machine screws secure the cover to the main support bracket.

Three connectors protrude from the bottom of the enclosure. Two Type-N connectors that are actually part of the coaxial relay handle connections for the feed lines from the station to the antenna. The control/power connection is made through an F connector (commonly used in 75-ohm TV systems). Inexpensive RG-59 shielded cable is recommended for the control/power line. To ensure good long-term performance, all RF connectors are silver plated. The cables that connect the relay and preamplifier are made from durable RG-142B coaxial cable with silver-plated conductors and Teflon® dielectric.

The preamplifier itself is one of the standard nonswitched ARR GaAsFET units that is self-contained in its own compact, black aluminum enclosure. At the low end of the 2-m band, gain is about 25 dB and the noise figure is about 0.5 dB, as measured on the HP8970A/HP346A setup (see Table 2). These measurements were made with the relay in the line and energized, as it would be in normal operation.

The relay, custom-made for this application by Dow Key/Kilovac, is a modified type 260. The normally closed contacts are connected together internally so that the station feed line is connected straight through to the antenna when power is not applied. More significant, the normally open contacts (those used to route the signal through the preamplifier for receive) are grounded when not in use. The result is an impressive 100-dB isolation. Even during full-power transmissions the amount of RF that can leak through the relay to the preamplifier input is tens of decibels below the level that would cause damage to the GaAsFET device.

The instructions stress the point that some type of sequencing must be used with this preamplifier/relay system. Unlike the MML144VDG, there is no RF-switched keying option. You *must* provide a 12- to 14-V signal to turn the unit on for receive (this signal energizes the relay coil and supplies

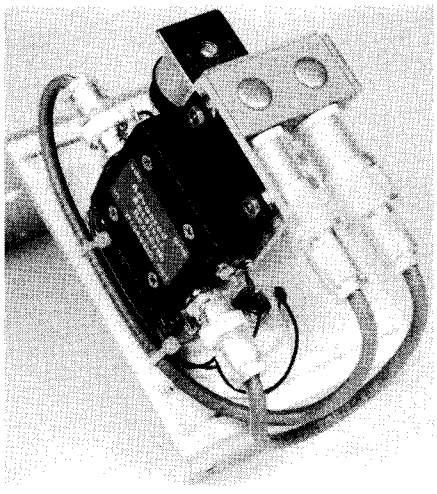


Table 2

ARR MM144VDG 2-M GaAsFET Preamplifier

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency range: 144-MHz band.	As specified.
Noise figure: Less than 0.55 dB.	144 MHz, 0.45 dB; 146 MHz, 0.43 dB; 148 MHz, 0.41 dB.
Gain: 24 dB.	144 MHz, 24.95 dB; 146 MHz, 24.66 dB; 148 MHz, 24.28 dB.
Compression point (1 dB): +12 dBm.	+10 dBm.
Power requirements: 12-V dc at 280 mA.	12-V dc at 270 mA (receive), and 10 mA (transmit).
Power handling (transmit): 1 kW.	Not tested at 1 kW power level, for lack of equipment. Operated at 500-W+ level for extended period.
Through-mode SWR: 1.15:1 max.	1.1:1.
Maximum insertion loss: 0.1 dB.	Insertion loss not detectable.
Operate time at 20°C: 25 ms.	31 ms, including 5 ms of bounce.
Size: 7-1/8 × 4 × 5 in (HWD), including mounting bracket.	
Weight: 2 lb 8 oz.	

power for the preamplifier), and you must remove this signal for transmit. The TRS04VD sequencer described later can be used to ensure that the preamplifier relay is keyed first, before the transmitter and power amplifier are keyed.

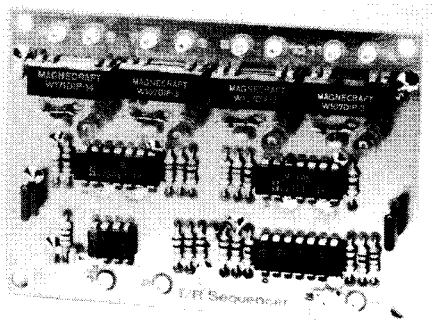
The MM144VDG is impressive because it does so much with so few parts. Operation couldn't be simpler—apply or remove 12 V. The relay will handle high power levels as long as it is not hot switched, and the preamplifier performance is fine for terrestrial, satellite or EME operation.

The weatherproof enclosure is designed so that chances of water getting into the unit are extremely remote. We purchased the unit for use on the OSCAR-10 satellite array at W1INF, the ARRL HQ station. We used it for a year before publishing this review. The performance measurements reported herein were made after the unit had been out on the tower for a year. When I removed the unit from the tower for testing, there was no trace of water in the box. The blue paint on the top cover wasn't quite as bright as when it was new and there was some oxidation on the unpainted aluminum mounting bracket, but otherwise the unit appeared and performed as it did when it was new.

Operation of the MM144VDG at W1INF was primarily for satellite work. The antenna is a KLM 22C cross-polarized Yagi fed with more than 100 feet of Belden 9913 coaxial cable. The preamplifier made a noticeable difference in reception of weak satellite downlink signals on a Kenwood TS-700S transceiver. On some signals, the preamplifier made the difference between hearing and not hearing the station.

TRS04VD TR Sequencer

The TRS04VD TR control board is important for the long life of a remotely mounted preamplifier. It provides sequentially keyed outputs to control the timing of all system TR changeovers. If you simply tie everything together and key your rig, power amplifier and relay simultaneously, you will probably start transmitting before the preamplifier relay contacts have finished switching and bouncing. When this happens, there is a good probability of arcing and ruining the relay contacts, as well as applying some transmitter power to the preamplifier.



Operation of the TRS04VD is straightforward. Once you apply the "master" TR command from your transceiver, the sequencer takes over and switches the other components in the system. The TR command can be either a ground-to-transmit or a positive-voltage-to-transmit signal. The one you choose will depend on your particular rig.

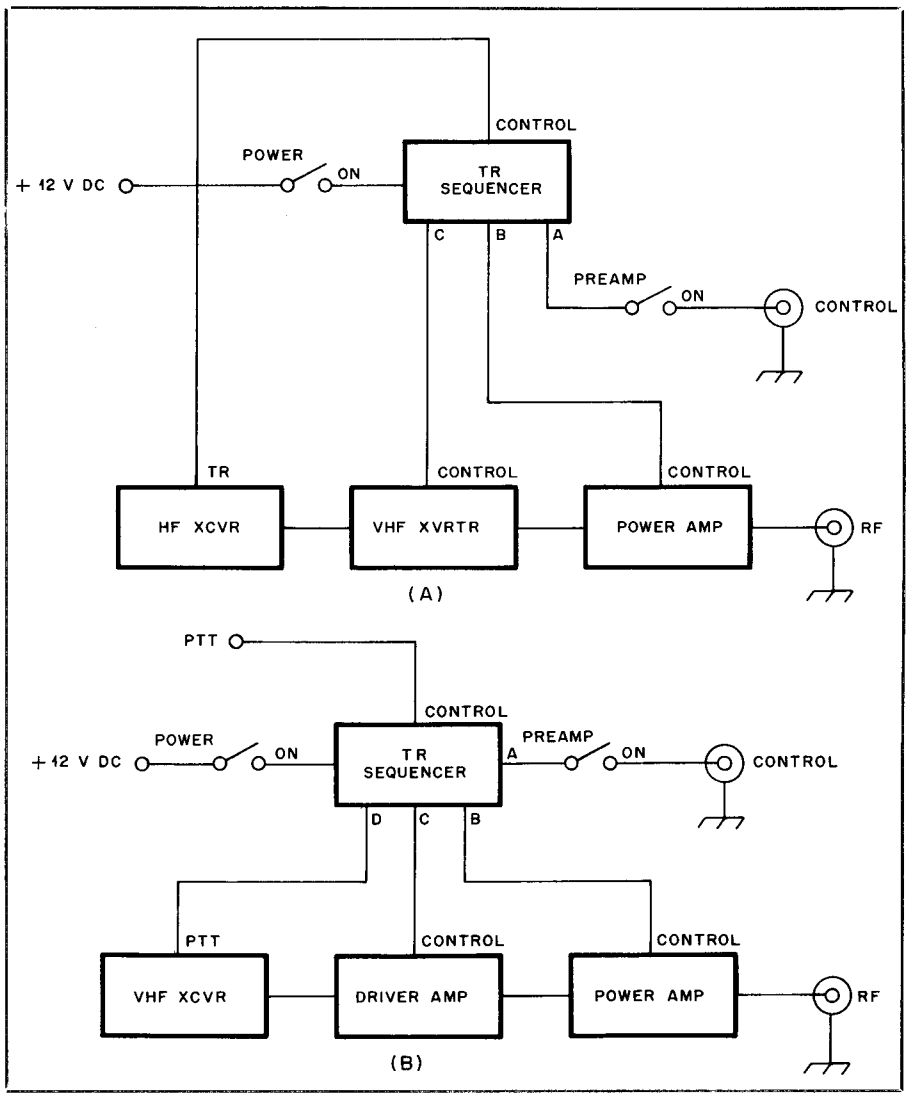


Fig 1—Two typical preamplifier/relay hookup schemes utilizing a TR sequencer.

There are four keyed outputs that can be used in several ways. Two common hookups are shown in Fig 1. For a system including an HF transceiver, VHF transverter, driver amplifier and high-power amplifier, a typical sequence of events would be something like this: Approximately 8 ms after the TR command is given, the first sequencer output is keyed, switching the mast-mounted preamplifier/relay to the transmit position. About 30 ms later, the power amplifier is keyed, and 30 ms after that the driver amplifier is keyed. Another 30 ms go by and the VHF transverter is keyed, applying RF after everything else in the system is keyed and ready to go. The whole sequence takes about 100 ms, and is reversed to get from transmit back to receive (see Table 3).

All of the TRS04VD components mount on a double-sided PC board. No cabinet is supplied, so the board can be mounted in its own enclosure or even inside a radio or amplifier. Output switching is accomplished with reed relays. Depending on your particular application, you can order the unit with any combination of relays with contacts that are normally open, normally closed or mercury wetted (for high-voltage or high-current applications).

If you want to dig a little deeper into the noise on your favorite VHF or UHF band, ARR probably has a switched preamplifier to suit your needs. Manufacturer: Advanced Receiver Research, Box 1242, Burlington, CT 06013, tel 203-582-9409. Price class: MML144VDG, $180; MM144VDG, $280; TRS04VD, $50.—*Mark Wilson, AA2Z*

Table 3

ARR TRS04VD TR Sequencer Switching Times

Output	Delay From Initial TR Command Until Output Relays Operate (ms) Key Down	Key Up
A	8	170
B	41	140
C	72	109
D	104	79