

Q5 SIGNAL VHF/UHF TRANSVERTERS

A Down East Microwave Product Manufactured by Q5 SIGNAL, LLC

Part Number L70-28 **SN** _____

Transverter Configuration

| | | |
|------------------------|---|--|
| Power Out Maximum: | <input type="checkbox"/> 25 W linear <input type="checkbox"/> Other _____ | |
| Noise Figure and Gain: | <1.0 dB maximum @ 17 dB conversion gain minimum | |
| DC Power Requirement: | 11.5 - 15.5 VDC @ <input type="checkbox"/> 6 Amp Max. <input type="checkbox"/> Other _____ | |
| RF Option: | <input type="checkbox"/> Common | <input type="checkbox"/> Separate TX and RX (Split) |
| IF Option: | <input type="checkbox"/> Common | <input type="checkbox"/> Separate TX and RX (Split) |
| IF Drive Level: | | |
| Keying Option: | <input type="checkbox"/> PTT-L (to ground) <input type="checkbox"/> PTT-H (Positive Voltage) <input type="checkbox"/> Transverter <input type="checkbox"/> Sequencer <input type="checkbox"/> Transverter <input type="checkbox"/> Sequencer | |
| IF Drive Sense: | <input type="checkbox"/> IF Drive Sense | |
| Aux Connector Pin # | Transmit | Receive |
| 1 (Sequencer step 1) | <input type="checkbox"/> High <input type="checkbox"/> Low <input type="checkbox"/> Open | <input type="checkbox"/> High <input type="checkbox"/> Low <input type="checkbox"/> Open |
| 2 (Sequencer step 2) | <input type="checkbox"/> High <input type="checkbox"/> Low <input type="checkbox"/> Open | <input type="checkbox"/> High <input type="checkbox"/> Low <input type="checkbox"/> Open |
| 3 (Sequencer step 3) | <input type="checkbox"/> High <input type="checkbox"/> Low <input type="checkbox"/> Open | <input type="checkbox"/> High <input type="checkbox"/> Low <input type="checkbox"/> Open |
| 4,5 | | |
| 6,7,8 | Ground | Ground |
| 9 | PTT | PTT |

Additional Specified Options:

Configuration Overview: This transverter is designed to interface and operate with most High Frequency transceivers that are available on the market today. Your assembled unit has been configured to your specifications to interface with your desired transceiver. This configuration may be changed or altered at any time if you desire to utilize a different transceiver or change your system configuration. Let's review your configuration and verify that your interface will be trouble free. Please refer to the front page.

Part Number Verification: All transverters contain the operating frequency within the part number. For example, L70-28 means that 70 MHz is converted to 28 MHz. If you ordered a special frequency conversion, it will be listed here. Also, please understand that the conversion is simple math. If you desire to operate on 70.100 MHz with your L70-28, it will require you to tune your transceiver to 28.100 MHz.

Power Out Maximum: The output power will be indicated or marked ***other*** with a hand written level on the line. This level, 25W or other, is the ***linear*** output power level that should not be exceeded if linear operation is expected. The transverter may be capable of producing higher output power. But it is not recommended because of excessive heating that will interfere with its frequency stability while producing excessive distortion products

Noise Figure and Gain: The noise figure and gain listed are nominal minimum requirements and most transverters exceed these specifications. In utilizing the latest PHEMPT technology, we have designed the complete receive section of the transverter with extra filtering, duplexing, and gain management in mind. There is also a RXIF gain control that is adjusted by the user to set the "S" meter level on the transceiver. External receive pre-amplification interfacing will be covered later in this document.

DC Power Requirement: The DC power requirement is listed and should be used as a guideline. The standard and high power transverters do require different supply currents. Please include some "head room" in your power supply to eliminate voltage drop delivered to the transverter. We recommend a 10-Amp supply for the standard power transverters.

RF Option: The RF option is either a single port (Common RF) for both TX and RX or there will be two separate ports, (Split RF) one RX and one TX. The transverter may be changed from Common to Split if the user desires. This will be covered in the manual. The TR relays are controlled by the Push-to-talk (PTT) circuit.

IF Option: The IF options are much like the RF option but in reverse. The transverter may be set up as Split IF (separate TXIF and RXIF in/out lines) or can be configured as a Common IF. There is an on-board relay that will switch the RX and TX to the correct direction as controlled by the PTT circuit.

IF Drive Level: The IF Drive Level is adjustable over a 15-20dB range using the TXIF gain control. Proper adjustment of this level will allow your transverter to operate at its maximum linear output power. The overall drive level range is determined by different sets of attenuators and gain stage levels as required.

Keying Option: The keying options are either PTT-L or PTT-H. PTT-L requires a connection to Ground to transmit. This is the most common keying option. PTT-H requires a voltage between 1.7 and 17VDC to transmit. This option can also be placed on the IF coax if desired. If you want the sequencer to be utilized, the PTT connection will go directly to the sequencer to key it. It in turn will key the transverter on the last step of the sequence. Now doing so creates other problems if you choose to use a High IF drive level (above 200 mW). This is covered in the **Options:** section of this document.

Options: The **IF Drive Sense** option will be installed with any IF drive level above 200 mW. This is a protection circuit that will prevent excessive IF drive levels from damaging the RXIF circuitry and the Mixer. When utilizing a high-level IF drive transceiver, the IF drive is applied at the same time as the PTT is energized (unless your transceiver has some sort of delay circuit built in). If the transverter's sequencer is utilized, the transverter will be keyed last in the sequence. This will result in the high level IF drive being applied to the transverter's RXIF section which could cause damage to the circuit and Mixer. The IF Drive Sense circuit detects high-level drive and enables the TXIF attenuator. This is done to protect the transverter's RXIF section and Mixer. It then holds and waits for the Transverter to "Catch up" in the sequence. This circuit will allow a user to key the sequencer circuit with the standard PTT circuit of a transceiver without having an issue or requiring external wiring or modifications to the PTT circuit.

This circuit will also protect the transverter in case the PTT circuit fails between the transverter and the transceiver. If the transverter is keyed directly with the PTT (sequencer is disabled) it will function normally.

The IF drive sense circuit should not be used to key the sequencer because it will produce long delays between transmit and receive or chop off the beginning of a transmission. If the transverter is configured with the IF drive sense enabled for any other purpose than protection, it will be discussed with you before delivery to assure its proper operation.

Aux Connector Pin #: The AUX connector is just that. All other I/O's of the transverter are found in this connector. All transverters will have the sequencer pre-wired and will be indicated how it is configured. There are extra pins in the connector and may be specified by the user for various IN/OUT configurations. They will be indicated as such.

Customer Specified Options: All other customer specified options will be listed and identified. If for the reason of installing, other options were eliminated, it will be specified and detailed with any special instructions required for correct operation.

Installation

Theory of Operation: The basic principle of a VHF/UHF transverter is to convert a chosen band of operation to the 28 MHz. band of a HF transceiver. Following the recommendations of the HF transceiver's operation manual for transverter use is the most important aspect of correct transverter operation. If configured correctly, the transverter will convert both transmit and receive signals to a new band of operation and seem "invisible" to your HF transceiver's operation. In simple terms, the transverter will not improve the performance of your HF transceiver but will not cause any degradation of performance in any way.

Interfacing and Operation: The interfacing starts with a complete understanding of your HF transceiver and manual. The manual should cover the setup for transverter operation and the connections to be made to the HF transceiver. Some transceivers are simple and some are complex. Some transceivers may have more than one correct way of interfacing. Hopefully, you have decided on how this transverter is to be interfaced at the time of order so we were able to configure the transverter to fit your requirements. If you find that this transverter is not configured correctly, refer to the **Option Setup** section of this manual concerning changing of configuration or contact us directly. All configurations are user changeable and detailed instructions are included.

Start the interfacing with good quality 50 ohm cables for the IF (28 MHz.) and 10 MHz. connections. These connections are low level (25 watts or less) and are BNC connectors on the transverter. Your HF transceiver may have various other types of connections. We find that simple RG-58 type BNC cables work fine with or without adapters to your HF transceiver. All transverters will require a PTT (to ground or positive voltage on TX) to enable the transmit mode of the transverter. The PTT input to the transverter is a RCA connector. This cable does not need to be shielded, but extra protection in a QRO station is a good idea! Most transceivers have RCA connectors for PTT outputs but others have various connections. Be sure to have whatever cable that is required ready to go. The DC power cable is supplied with the transverter and needs to be prepped and fuse-protected on the power supply end. The AUX connector will contain all sequencer connections and any other special customer requirements. The matching connector to the AUX connector is supplied and should be wired before interfacing unless further testing of your system is required.

Connect your transceiver to the transverter: Interfacing the transverter to the transceiver is easy. After reviewing the front-page configuration and verifying that it is configured correctly for your purpose, begin cabling. **An Important note:** It is recommended that during the initial setup of the transverter, that it is not connected to your complete system with a HPA or mast mount LNA. All aspects of the transverter's performance should be tested before a complete installation is made. Drive levels need to be established and proper switching needs to be verified before complete integration.

1. Connect the DC POWER to the transverter with the supplied cable. 13.8 volts is optimum but the transverter will operate from 11 to 15 volts. Verify the DC power consumption of the transverter and use a power supply with some headroom. Cycle the power switch on the transverter and verify the Green light. Leave the transverter powered off.
2. Connect an optional external 10MHz Reference to the 10MHz REF connector.
3. Connect the IF cable(s). The transverter may have a common IF port or two separate ports, TXIF and RXIF, for the IF connections. The connector labeled "IF" is either the common port or the RXIF port depending on your requested configuration. Verify on the first page. The IF cable is either connected to a transverter port connector or the main Antenna connection of your transceiver. Refer to your manual.
4. Connect the "Push-to-Talk" line out of your transceiver to the transverter. It is a RCA connector labeled PTT on the transverter. Refer to the configuration sheet for the type of keying required.
5. If separate TX and RX ports were ordered, the internal transfer relay option has not been assembled. The separate ports are labeled TX and ANT/RX. If you have requested a common RF connection, the "ANT/RX" port has both TX and RX functions. Connect your antenna system or dummy load with a power meter to the appropriate RF connector on the transverter.
6. On the bottom of the transverter, verify the TXIF and RXIF gain controls in the transverter. Turn the RXIF control fully clockwise and the TXIF control counter-clockwise. This is maximum attenuation on Transmit and minimum attenuation on Receive.

7. Power your transceiver "ON". If your transceiver cycles during power up, it may key the transverter. This is indicated by the Red "XMIT" light and the sound of relays cycling. Verify that the HF transceiver is in "receive" and that the red XMIT light is off on the transverter. If not, shut off your HF transceiver and check the PTT connection with the IF cables disconnected from the transverter. If both transceiver and transverter are in their receive modes, tune the transceiver to a frequency between 28.100 and 28.250 Mhz. Unless you ordered a "non-standard frequency" transverter and then depending on the conversion frequency, select an IF frequency in the middle of your operation range.
8. Observe the noise level in the transceiver on the "S" meter and by ear. If it is too high, adjust the RXIF gain control in the transverter counter-clockwise until a slight noise increase is heard in the transceiver or just a slight movement in the "S" meter is detected. Power the transverter on and off to verify the change. The RXIF gain may be increased beyond this point, but it will start to degrade the dynamic range of your transceiver. It is all user preference. If you plan to use an external or mast mount LNA, this level will need to be re-adjusted. Find a signal on the band or use a signal generator to determine correct frequency, or minimum signal level.
9. It is now recommended to test the transverter's transmit section in the CW mode because most transceivers have carrier level or power level controls in this mode only. Do not use full or semi break-in if possible. Do not use FM, SSB or AM because it may not be possible to obtain maximum output power with a transceiver in these modes. Set the carrier/output power control to minimum or "0" output power (if you can). Place the transceiver into transmit. If the PTT circuit is connected correctly, the red "XMIT" light on the transverter will switch on. While observing the built in relative power meter or an inline RF power meter, slowly increase the carrier control (with key down) or increase the power output control to the maximum desirable IF drive level obtainable by your transceiver (maximum of 25 watts!) If this level is not what is indicated on the front page of this document, do not exceed that level. If you find that the transverter is not set-up for your transceiver's range, go to the **Option Setup** section and re-configure the transverter before further testing.

If the transverter is configured correctly for your transceiver, minimal power may be detected on the power meter. With the transceiver's drive level at maximum specified for the transverter, slowly adjust the TXIF control in the transverter in a clockwise direction while observing the power meter. Set it to any desired level between 0 and the maximum specified output power. The relative power meter is set to show 9 bars lit for the specified maximum linear output power. This may vary with a bad VSWR but will be true into a 50 ohm dummy load. Switch the transceiver to USB and make a transmission. The power output and current drain should correlate to your speech pattern.

10. You may re-adjust both RXIF and TXIF again if desired. The receive amplifier section and internal reference frequency should not need to be adjusted but you may if you wish. Do not adjust any of the helical filters unless you have access to a spectrum analyzer at a minimum.
11. The AUX connector mate may be now wired for your installation. If you require something other than what is indicated on the front page, please see the **Option Setup** section for further details. Also read further about interfacing and testing a mast mounted LNA in that section.

Basically, the transverter is ready to use and may be integrated into your system. If your system requires the use of the sequencer or you desire to implement it, please refer to the **Option Setup** section of this manual.

General Operation: General operation of the transverter, if everything is adjusted correctly, should be transparent to the transceiver and the user. Except for the frequency read out, (if your transceiver doesn't allow its display to be adjusted for transverter operation) it will be like operating on 10 Meters. All of the functions of the transceiver (filtering, DSP, split band operation, dual VFO) will be transposed to the frequency band of the transverter.

Some cautions should be taken when operating CW or VOX. Operating the transverter in a "Full Break-in" mode is not recommended. Because of the mechanical relays in the transverter, there will be too much delay to operate "Full Break-in" effectively. AND—the relays would be abused if "Full break-in" is enabled. It is best to operate in "semi break-in" and adjust the delay of the PTT on your transceiver to match your comfortable CW operating speed in a way that the delay will hold the PTT until your transmission is complete. Since all transverters will be delivered with the sequencer enabled, this delay will need to be longer to allow all components within the system (Power amplifier, LNA, relays,) to complete their transition if utilized. If the stock transceiver is to be used alone, the transceiver PTT signal may be connected directly to the transverter's PTT input if the sequencer is bypassed. This will shorten up the delay but will not allow "full break-in" without relay chatter. See the **Sequencer Operation** in the **Option Setup** section of this document.

The "LOCK" LED will be lit when the Frequency Synthesizer is locked to an optional external 10MHz Reference. This level should be between 0dBm to +13dBm. At levels below 0dBm, the synthesizer automatically switches to its on-board reference. And the "LOCK" LED will be off.

Option Setup:

Common or Split IF Option: The IF configuration may be changed at any time according to the type of transceiver you are utilizing. The component designators are silk screened on the printed circuit board.

K3 is the common IF relay. To split the IF lines into separate RXIF and TXIF, remove the IF coax from its position on the board (junction of C93 and C94) and re-attach the center conductor between C95 and K3. The shield may be now soldered where it was on the ground pad marked COM. The TXIF cable can be prepped and soldered to the pad between K3 and C92. The shield can be soldered to the ground pad labeled TXIF. Install a BNC connector in the rear panel (TXIF) and attach the TXIF coax. Reverse the procedure if you want to change to or back to Common IF.

Please note that if you have a separate IF configuration, the IF drive sense option will no longer function. It is not necessary with the split IF. It is to protect the RX circuit and Mixer.

TXIF Drive Level Range: The TXIF drive level range can be changed at anytime to conform to your transceiver type. Basically, there are three configurations. For high IF drive levels, (250 mW-25 watts) the 50 Ohm load will be installed with a low value capacitor in the C91 position (10 pF or less for 25 watts). Mid level drives between 1mW and 250 mW will not have the load installed and will have a 1000 pF capacitor installed for C91. For the low drive levels (-20dBm to 0dBm or 1mW) IC7 will be installed. If you desire to change the drive level for whatever reason, just duplicate the info above. To install IC7, remove the bypass jumper before installing. For -10 to -6dBm inputs, use a MAR-3 for IC7. For -20dBm, use a MAR-6. Other MMIC's may be used but the bias resistor R33 may need to be changed. Adjust R36 to obtain the desired level in all cases.

IMPORTANT NOTE: Do not assume that low transverter output power is due to inadequate IF drive. Please consult Q5 SIGNAL if you have problems obtaining full output power with your specified drive level.

Common or Split RF connections: K2 is the common RF relay. It may be removed and two separate type “N” or UHF connectors may be installed in the rear panel with coax to the C62 pad for RX and the C57 pad for TX.

If you have separate ports and wish to make them common, you can order and install relay K2. Or Q5 SIGNAL can do it for you for a minimum charge.

BUT- a relay may be purchased to be mounted on the outside and it may be wired through the AUX connector. The relay’s DC power is found on the pad labeled TXON by CR1. This setup is also the most versatile.

Sequencer: The sequencer configuration may be changed at anytime. If it was specified to be utilized, the transverter is connected to the 4th and last step of the sequencer. It is wired to the #4 point on the circuit board in the sequencer section. This is a “LOW” on transmit. The other connections are indicated on the front page and wired to the AUX connector. The reasoning is:

Step 1 +12VDC on RX for a preamp @ 500 mA maximum

Step 2 +12VDC on TX for a TR relay (around the preamp) @ 500 mA maximum

Step 3 Ground on TX to key a power amplifier. Sinks 100 mA maximum

Optional Sequencer Connections:

Step 1 and 2. They can be connected to switch higher DC voltages. The DC voltage is applied to the DC1 and DC2 connections on the board (30VDC, 100 ma. maximum). Higher current at higher voltage, such as with multiple TR relays, may be switched on step 2 if the circuit is re-wired. The yellow wire in Via #2 near Q10 is removed and replaced with a connection to ground. The yellow wire is then placed in the DC2 connection. This will now pull any relay up to 500 ma to ground.

Step 2 TL2 is a secondary connection to the second step. It is a “LOW” on transmit. It can be used to drive a relay or key an amplifier but an external isolation device should be utilized. It will sink 100 mA maximum

Step 3 and Step 4. They have secondary outputs that are both “High” on transmit. They are labeled PH3 and PH4. These should be isolated from devices that require high currents and are intended to drive low current devices like FETs. They will source 5mA.

For mast mount LNA operation with the basic transverter or with an external high power amplifier, all tests should be done without RF applied. Verify that the switching is completed in your desired sequence and gradually add in external components as verified. The last should be the transverter’s RF applied. All testing can be done without coaxial cables connected. Connect the transverter’s IF or TXIF cable last.

The transverter’s sequencer may be bypassed to eliminate switching time delays but is only recommended if the transverter is to be used without any other system components such as LNAs or power amplifiers. In this case the external PTT input of the transverter may be connected directly to the transverter’s PTT input (see component placement document) near C100 (PTT-H) or C102 (PTT-L) bypassing the sequencer.

Relative Power Meter: The bar graph display is a relative power meter and is driven by the directional coupler and RF detector circuit found in the Low pass filter section of the board (CR11, R76,R75,C108) RF is detected and converted to DC voltage and conducted to the Bar graph display on the front panel. If you find that you operate the transverter at any other level than what we have calibrated it to (25 watts = 9 bars) you may change it by adjusting VR1 on the display board.

Other Adjustable Circuits: The Reference Oscillator frequency may be adjusted through a small hole in the TCXO located on the synthesizer board. It's frequency may be monitored at the junction between C29 and M1. Adjust as desired! But be sure the transverter has been "ON" for at least 15 min before measuring frequency. Frequency will shift over time so adjustment is expected.

The Receiver front end (the FET Circuit) should not need adjustment. It is aligned and tested into a 50-ohm test setup and optimized on a Noise figure meter. No adjustment should be necessary unless the FET is replaced.

All filters are aligned by the manufacture for input/output match and pass band ripple. Adjustments are not recommended or required. It's rare to have a failure of a passive component unless excessive "tweaking" has occurred.

DEM 70-28 COMPONENT LIST

Resistor (R) values are in Ohms and are chips unless otherwise specified

| | | | | |
|----------------|------------|----------|---------|----------|
| R1 1K | R30 51 | R43 470 | R56 10K | R69 10K |
| R2-R17 NA | R31 12 | R44 10K | R57 10K | R70 10K |
| R18 39(1210) | R32 51 | R45 220K | R58 1M | R71 10K |
| R19 470 | R33 1K | R46 1M | R59 10K | R72 1M |
| R20 330 | R34 330 | R47 10K | R60 220 | R73 10K |
| R21 150 ½ LEAD | R35 220 | R48 10K | R61 10K | R75 100 |
| R22 51 | R36 1K POT | R49 1K | R62 10K | R76 51 |
| R23 470 | R37 220 | R50 5.6K | R63 1M | R77 1K |
| R25 12 | R38 1K POT | R51 5.6K | R64 10K | R78 220 |
| R26 24 | R39 220 | R52 22K | R65 220 | R81 5.6K |
| R27 12 | R40 220 | R53 470 | R66 10K | R82 5.6K |
| R28 51 | R41 10K | R54 10K | R67 10K | R84 5.6K |
| R29 51 | R42 10K | R55 10K | R68 1M | |

All inductors (L) are in μ H and are 1008 chip unless otherwise specified.

| | | |
|------------------------|-------------------------|-----------------|
| L1-L4 NA | L15 7 Turns #24 T37-12 | L23 150 |
| L7 150 | L16 6 Turns #24 T37-12. | L24 220 |
| L8 330 | L17 9 Turns #28 T25-10 | L25 150 |
| L9 330 | L18 330 | L26 330 |
| L10 150 | L19 220 | L27 330 |
| L11 1.0 μ H | L20 56 | L30 1.0 μ H |
| L13 6 Turns #24 T37-12 | L21 1.0 μ H | L31 1.0 μ H |
| L14 7 Turns #24 T37-12 | L22 330 | |

All capacitors (C) are in pF and are chip unless otherwise specified.

“E” = Leaded Electrolytic “T” = chip Tantalum

| | | | |
|-------------------|------------------------|-------------------|--------------------|
| C1 1000 | C47 0.1 μ F | C69 0.1 μ F | C92 1000 |
| C2 – 23 NA | C48 0.1 μ F | C70 75 | C93 1000 |
| C24 1000 | C49 1000 | C71 24 | C94 10 (OPT) |
| C25 100 | C50 1000 | C72 1000 | C95 1000 |
| C26 220 | C51 0.1 μ F | C73 1000 | C96 1000 |
| C27 100 | C52 100 | C75 4.7 μ F T | C97 1000 |
| C28 1000 | C53 100 μ F E | C76 0.1 μ F | C98 0.1 μ F |
| C30 100 | C54 75 | C77 0.1 μ F | C99 4.7 μ F T |
| C31 100 | C55 75 | C78 1000 | C100 1000 |
| C32 0.1 μ F | C56 75 | C79 1000 | C102 1000 |
| C33 NA | C57 1000 | C80 1000 | C103 22 μ F T |
| C34 1000 | C58 100 | C81 56 | C104 4.7 μ F T |
| C35 - 38 NA | C59 0.1 μ F | C82 150 | C108 1000 |
| C39 4.7 μ F T | C60 4.7 μ F T | C83 150 | C110 220 |
| C40 0.1 μ F | C61 0.1 μ F | C85 150 | C112 100 μ F E |
| C41 NA | C62 1000 | C86 56 | C113 43 |
| C42 NA | C63 2-12pF SMD Trimmer | C87 1000 | C114 43 |
| C43 1000 | C64 2-6pF SMD Trimmer | C88 1000 | C115 10 μ F T |
| C44 1000 | C66 0.1 μ F | C89 0.1 μ F | C116 1000 |
| C45 1000 | C67 0.1 μ F | C90 1000 | C122 1000 |
| C46 1000 | C68 1000 | C91 10 or 1000 | |

Solid State, Relays and Filter Components

| | | |
|-------------------|-------------------|--------------|
| CR1 MMBD914 | F3 70M-2 pole | Q6 ATF33143 |
| CR3 MPN3404 | F4 70M-2 pole | Q7 PMBT3904 |
| CR4 MPN3404 | IC2 MMG3H21NT1 | Q8 MJD31 |
| CR5 1N914 or 4148 | IC3 MAR3 | Q9 PMBT3904 |
| CR6 1N914 or 4148 | IC4 MAV11 | Q10 MJD32 |
| CR7 HP2800 SMD | IC5 RA30H0608M | Q11 PMBT3904 |
| CR8 HP2800 SMD | IC6 PHA-1 | Q12 PMBT3904 |
| CR9 MMBD914 | IC7 MAR6 (option) | Q13 PMBT3904 |
| CR10 1N4000 type | IC8 LM393 | Q14 MJD31 |
| CR11 HP2800 SMD | IC9 LM324 | Q15 PMBT3904 |
| CR12 MMBD914 | K1 D2n | Q24 PMBT3904 |
| CR13 MMBD914 | K2 G5Y or G6Y | Q26 PMBT3904 |
| CR14 1N4000 type | K3 G5Y or G6Y | VR3 78L05 |
| CR21 MMBD914 | M1 SYM18H | VR4 78M05 |
| F2 71M-3 pole | Q5 PMBT3904 | VR5 78S09 |