

# DIY599.com

RF linear power amplifier with build-in antenna tuner (ATU)

## PA500

# INSTRUCTION MANUAL

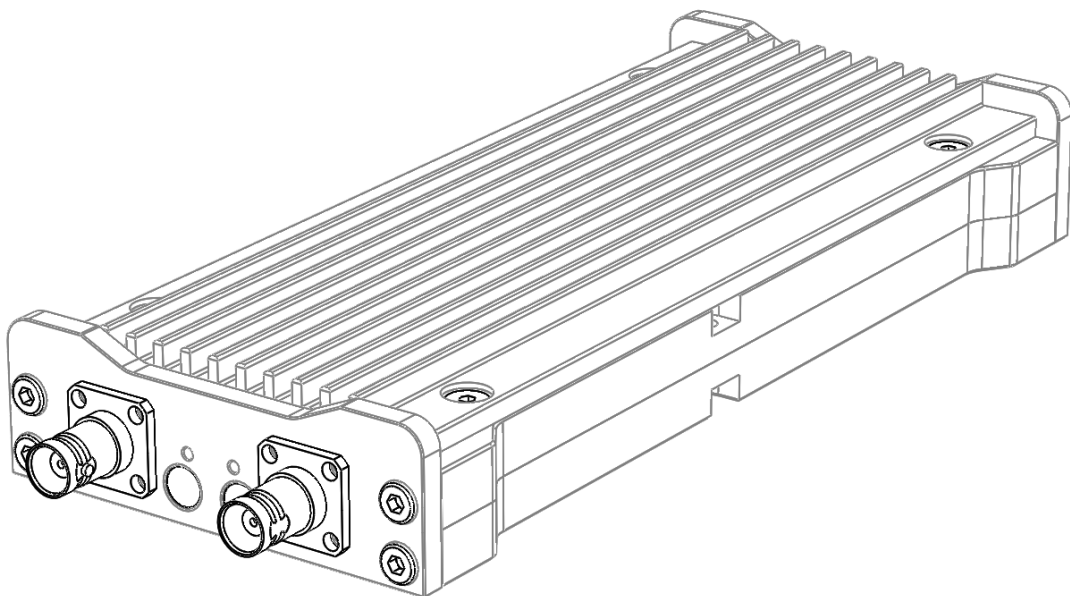
Version 2.9 / Revision 2

operating frequency range between 3.5MHz-30MHz

The device requires an amateur radio transceiver to operate.

This device is for use by licensed radio amateurs only

FCC-ID: 2A2IEPA500



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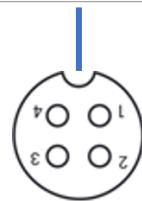
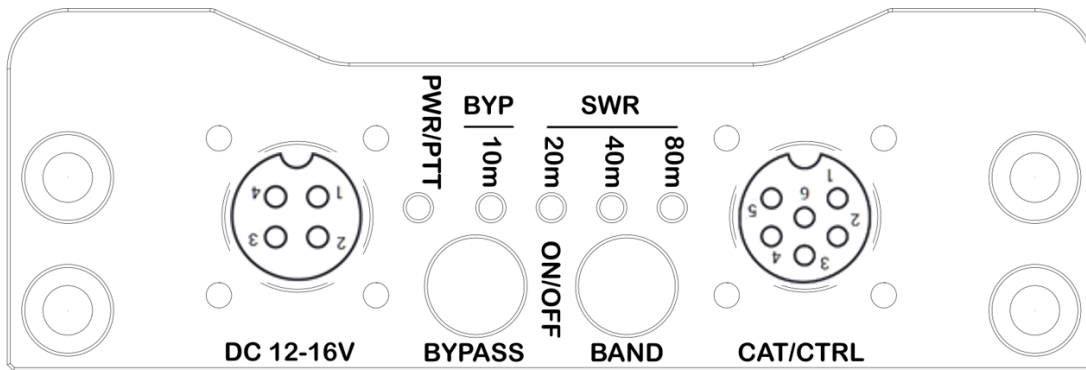
# Changes

To previous revision of this manual

Version / revision	changes
V2.6 / 1	Manual refer to PCB version < V2.9
V2.9 / 2	<p>Manual refer to PCB version V2.9</p> <p><b>CAT Interface changes:</b> Pin 6 has 12V/150mA (instead of 5V/100mA) Pin 5 has a PWM control signal to control a fan (temperature controlled)</p> <p><b>transmission modes and drive power section:</b> digital modes now have no longer power restrictions. If the unit is too hot, it is switched to bypass as long as the temperature is above the upper permissible limit.</p>

# connectors

left side



- 1 – GND
- 2 – GND
- 3 – DC IN (12-16.8V)
- 4 – DC IN (12-16.8V)

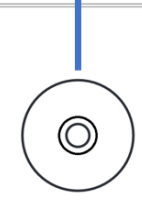
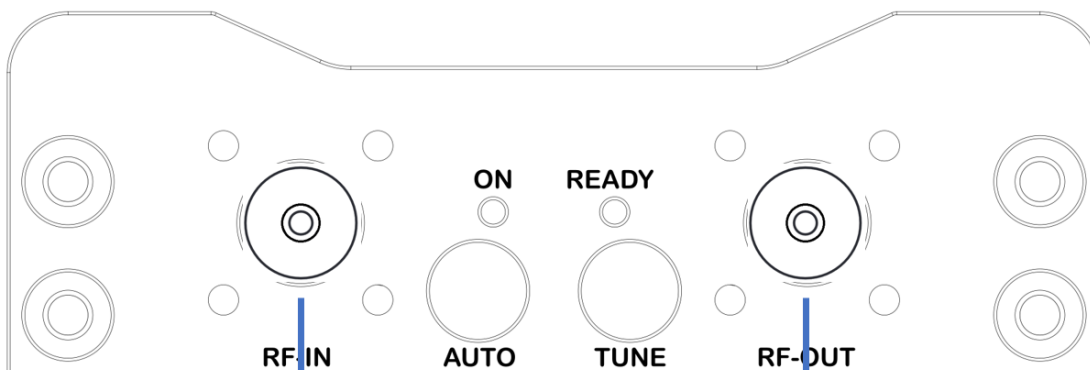


- 1 – GND
- 2 – TX DATA
- 3 – RX DATA
- 4 – PTT/KEY-IN
- 5 – fan PWM Signal (for HW > V2.8)
- 6 – 12V Source 150mA (for HW > V2.8)  
(5V Source 100mA for HW < V2.9)

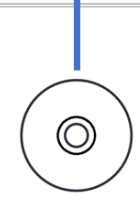


there is no reverse polarity protection, incorrect wiring will destroy the device.

right side



RF-IN



RF-OUT

# getting started

Before using the PA500, you'll need to connect a power source with sufficient power. We recommend to use a power source (a battery or an AC/DC power supply) which can provide 11 to 16.8V and up to 10A of continuous current.



**there is no reverse polarity protection, incorrect wiring will destroy the device.**

The PA500 need to be connected to a transceiver. In the simplest case, just connect the power cable and the antenna cables.

## powering up

After reading these brief instructions, you will be able to put the PA500 into operation.

1. Make sure that the transceiver with its RF-Out is connected to the RF-In connector of the PA500 using a suitable 50 Ohm antenna coax cable. A suitable antenna must be connected to the RF-Out connector of the PA500.
2. Please make sure that the Transceiver RF-Output-power is set to the correct level. See also section: 'operating mode and drive power'. Start with about 1W input drive power.
3. Turn on your transceiver and the PA500. To Power on the PA500, **TAP and HOLD the 'BAND' and 'BYPASS' buttons simultaneously for about 1 second**. After turn on, the white LED will light up. You can turn off the PA500 in the same way.
4. **The PA is always in the BYPASS mode after turning it on**. Tap the BYPASS Button once, the internal PA will be activated (armed). You can switch back to 'BYPASS' in the same way.
5. **The PA500 Amplifier supports automatic Band selection**. You can configure the PA500 into manual mode to set the band manually to operate.
6. Choose the antenna-tuner tuning-mode. You have the choice between **"full-automatic"** and **"semi-automatic"**. For 'full-automatic' mode, tap the 'AUTO' Button, the green light indicates the 'full-automatic' mode is switched on. The Antenna-Tuner will only work in the PA-Mode (armed). To use the semi-automatic mode, the full-automatic mode (AUTO off) needs to be switched off. To request a tuning, tap and hold the tune button until the ready LED is ON. Within the next RF carrier, the internal tuner will start tuning. You can also tune at any time while a RF carrier is applied by tap and hold the ready button, until the tuner finished the tune request.
7. Before you start to operate, tune your antenna, this must be done with an active PA (no BYPASS). It is recommended to switch to AM to tune the antenna with a steady carrier signal.

# LEDs and Button functions

## left side

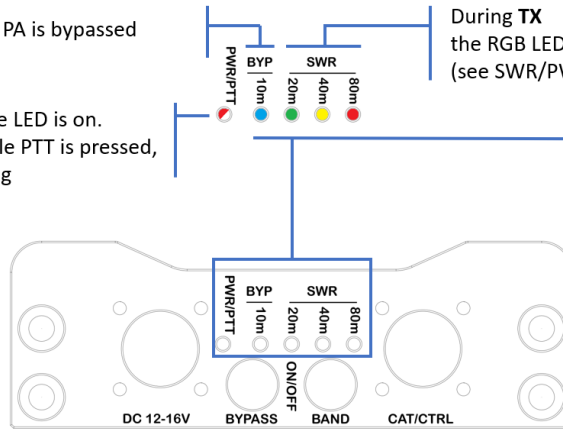
Blue LED blinking indicates the PA is bypassed

Device is powered ON if the white LED is on.  
LED will change to bright-red while PTT is pressed, It means the device is transmitting

During TX the RGB LEDs indicates the SWR or TX-Power (see SWR/PWR Indication)

BAND indication during RX  
Indicate which Band is selected

Red = 80m  
Yellow = 40m  
Green = 30/20/17m/15m  
Blue = 12/10m



**SHORT PRESS (TAP)**  
toggle between PA and BYPASS mode

**LONG PRESS (TAP and HOLD)**  
Toggle between SWR/PWR  
Indication during TX

**POWER ON/OFF**  
**TAP and HOLD**  
BAND and BYPASS  
for about 1 seconds

**SHORT PRESS (TAP)**  
toggle through supported Bands to  
select the Band to operate  
(manual Band Mode only)

**LONG PRESS (TAP and HOLD)**  
toggle between manual/automatic  
band selection (see manual Band selection)

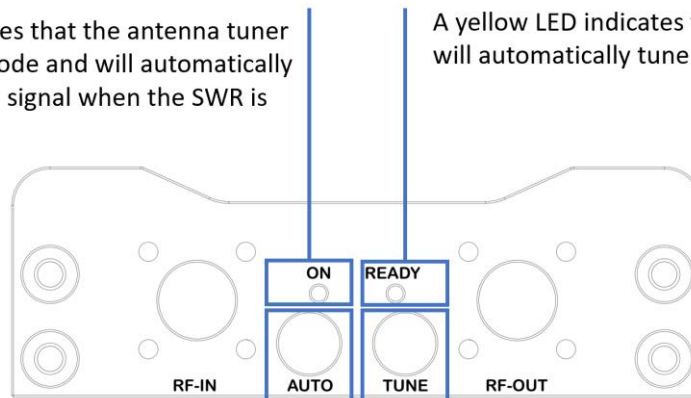


**in manual mode the correct Band must be selected, otherwise the PA will not transmit**

## right side

a green LED indicates that the antenna tuner is in auto-tuning mode and will automatically tune to the next RF signal when the SWR is greater than 1.5

A yellow LED indicates that the antenna tuner will automatically tune to the next RF signal



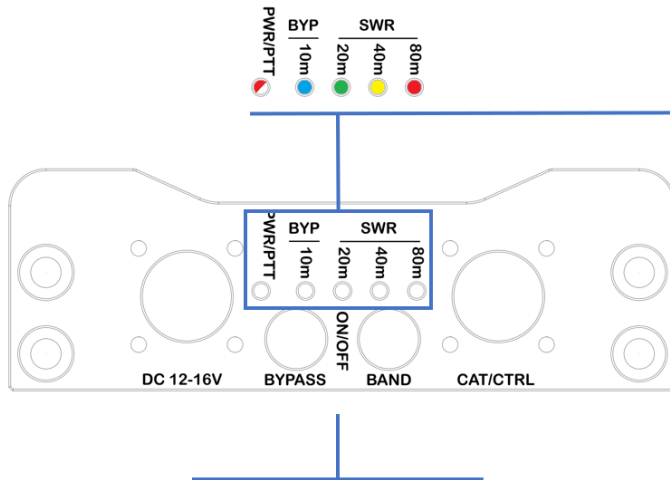
**SHORT PRESS (TAP)**  
Toggle between manual tuning mode  
and automatic tuning mode

**SHORT PRESS (TAP)**  
reset the antenna tuner  
It means the tuner is bypassed

**LONG PRESS (TAP and HOLD) during RX**  
Prepares the antenna tuner so that it automatically  
tunes within the next RF signal from the transceiver

**LONG PRESS (TAP and HOLD) during TX**  
initiate manual tuning when there is  
a proper RF signal from the transceiver

# device configuration



the binary code indicates which mode or transceiver is configured. Mode 2 (yellow LEDs on) is preconfigured

'see chapter: PA operation modes'

## BAND & BYPASS BUTTON

the two buttons have a secondary function:

*operation mode and RF-VOX delay setting*

## How to configure the operation mode

(The device is preconfigured, normally no changes needed)

1. PA must be powered OFF
2. TAP and HOLD the BAND and BYPASS Button for about 0.5 to 1 second
3. CONTINUE TO HOLD the BYPASS Button, release the BAND Button
4. PA will power ON, indicated by the White LED
5. toggle through the modes with the BYPASS Button
6. TAP the BAND Button to save your setting to the device
7. TAP and HOLD BYPASS and BAND Button to turn OFF the PA

see chapter: PA operation modes

## How to configure the RF-VOX delay

(The device is preconfigured, normally no changes needed)

1. PA must be powered OFF
2. TAP and HOLD the BAND and BYPASS Button for about 0.5 second
3. CONTINUE TO HOLD the BAND Button, release the BYPASS Button
4. PA will power ON, indicated by the White LED
5. toggle through the modes with the BAND Button
6. TAP the BYPASS Button to save your setting to the device
7. TAP and HOLD BYPASS and BAND Button to turn OFF the PA

see chapter: RF-VOX delay

## manual band selection

The PA500 has 4 Band selector settings 80m, 40m, 20m and 10m. Most of other Frequencies between these Bands can also be used. The table describes the selection that must be made for a specific Band to use. The manual band selection option is only accessible in the automatic mode.

operating Band	Band selector setting on the PA500	Band selector LED Color
80m	80m	RED
40m	40m	YELLOW
30m	20m	GREEN
20m	20m	GREEN
17m	20m	GREEN
15m	20m	GREEN
12m	10m	BLUE
10m	10m	BLUE



Only HAM frequencies are supported, Frequencies between 26-28MHz are not amplified

## SWR/PWR indication

**During transmit** the RED, YELLOW and the green LED will show the SWR which is achieved by the Tuner. This setting is pre-selected. Alternatively, the RF output power can also be displayed.

To toggle between both operation modes, **TAP** and **HOLD** the BYPASS Button.

SWR indication:	RF Power indication:
RED LED indicates a SWR > 2.5 <b>OR</b> YELLOW LED indicates a SWR 1.5 - 2.5 <b>OR</b> GREEN LED indicates a SWR < 1.5	NO LIGHT indicates RF Power < 10W GREEN LED indicates RF Power >= 10W GREEN <b>AND</b> YELLOW LED indicates RF Power >= 25W GREEN <b>AND</b> YELLOW <b>AND</b> RED LED indicates RF Power > 40W



## PA operation modes

Transceiver model	Interface type	Interface#	PA configuration pattern **
<b>all Transceivers</b> All transceivers with PTT out Signal	Manual mode	0	
<b>all Transceivers</b> automatic Band selection only	automatic Mode	1	
<b>all Transceivers*</b> automatic Band selection automatic RF-VOX PTT	automatic Mode*	<b>2*</b>	

\* Default setting

## RF-VOX delay

(From Firmware Version 2.8)

VOX delay value	LED Color
10	RED
15*	YELLOW*
20	GREEN
25	BLUE

\* Default setting

## good to know about BYPASS Mode

if the PA is operated in the interface Mode 0 (simple PTT controlled) AND the PA is in the **BYPASS Mode**, Band-Filters are off, no LED indication for Filter status. if the PA is operated in the interface Mode 1 and 2 AND the PA is in the **BYPASS Mode**, Band-Filter LED shows the status of the last selected Filter-Bank, but Band-Filter LEDs will switch off when the PTT is pressed. If the PA is in the **BYPASS Mode**, the Antenna Tuner is bypassed too.

## good to know about automatic Modes

In case you operate in the Mode 1 and 2 (see compatible Transceivers/configuration pattern). When you press the PTT button and you have selected a carrier modulation type, the PA will immediately make the appropriate filter setting. In the case of the carrier-less modulation type SSB, the appropriate filter setting is only set after the corresponding modulation. This means that the filters are not set by pressing just the PTT button, but are set as soon as a modulation takes place that generates enough RF-power for the internal VOX logic to configure the internal filters.

## good to know about RF-VOX

To make sure that the RF-VOX function will not react on background noise of the microphone, please adjust the microphone amplification on your transceiver to a level where the background noise is below the detection threshold of the RF-VOX feature.

## transmission modes and drive power

TX operating mode	max. drive power PEP	peak drive power PEP	max. PEP RF power*	transmit duty cycle @ max. RF power
SSB	3W**	5W	60W****/**	temperature protected**
CW	3W@12V, 2W@16V	-	60W****/**	temperature protected**
AM	3W@12V, 2W@16V	-	60W****/**	temperature protected**
FM	3W@12V, 2W@16V	-	60W****/**	temperature protected**
DIG	3W@12V, 2W@16V	-	60W****/**	temperature protected**

\* RF output Power can be reduced by the protection system depends on the case temperature

\*\* device will go into bypass when the device temperature reached 70°C

\*\*\* the maximum allowed output power is typically reached at an input power of 2W PEP

\*\*\*\* high operating voltage and peak input drive power, this setting may violate other operating conditions. if the nominal RF-Power exceeded by 1dBm, the PA will switch into the bypass mode.



**Overdriving the PA leads to the harmonic distortion exceeding the permitted limits. The PA switches to bypass mode when the maximum output power is exceeded by 1 dBm.**



**The maximum output power is achieved with a matched antenna. If the antenna is not matched, tune the antenna to the right impedance with the integrated antenna tuner.**

## Protective internal circuits

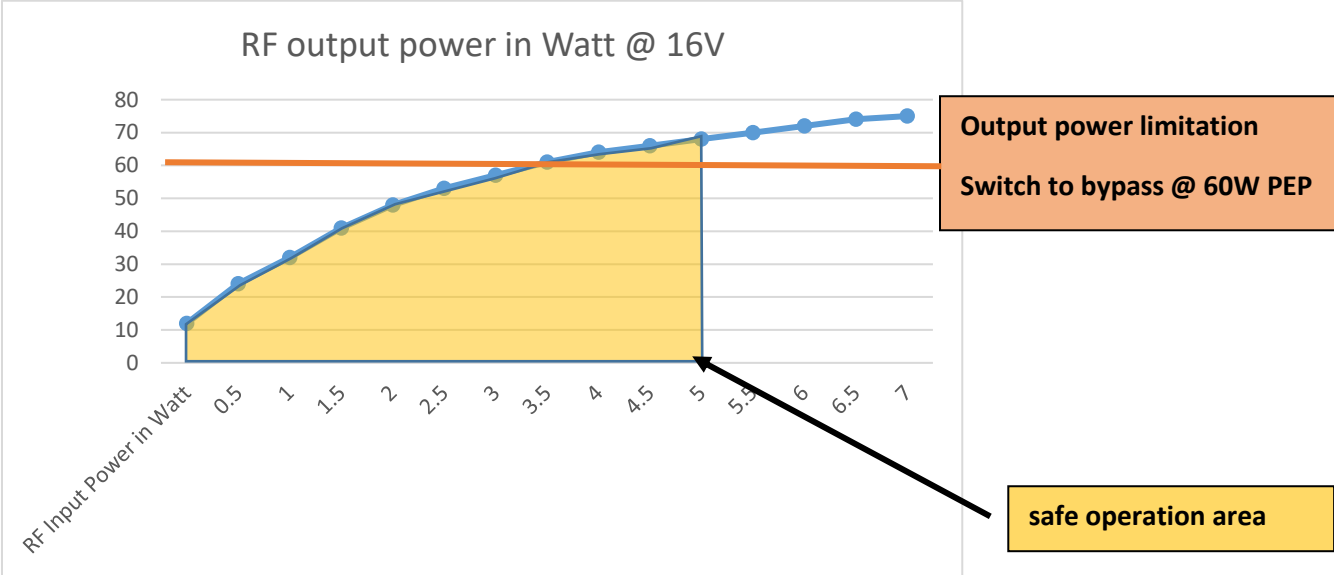
protective circuits	function
Gate voltage limiter	Protect the RF LDMOS FET amplifier
Temperature monitoring	Control output power by temperature
Output power monitoring	Overpower protection switch
Overcurrent fuse	Overcurrent shut-off
High output power protection	output power shut-off (PA-bypass)
High input power protection	input power shut-off (PA bypass)

## safety alerts

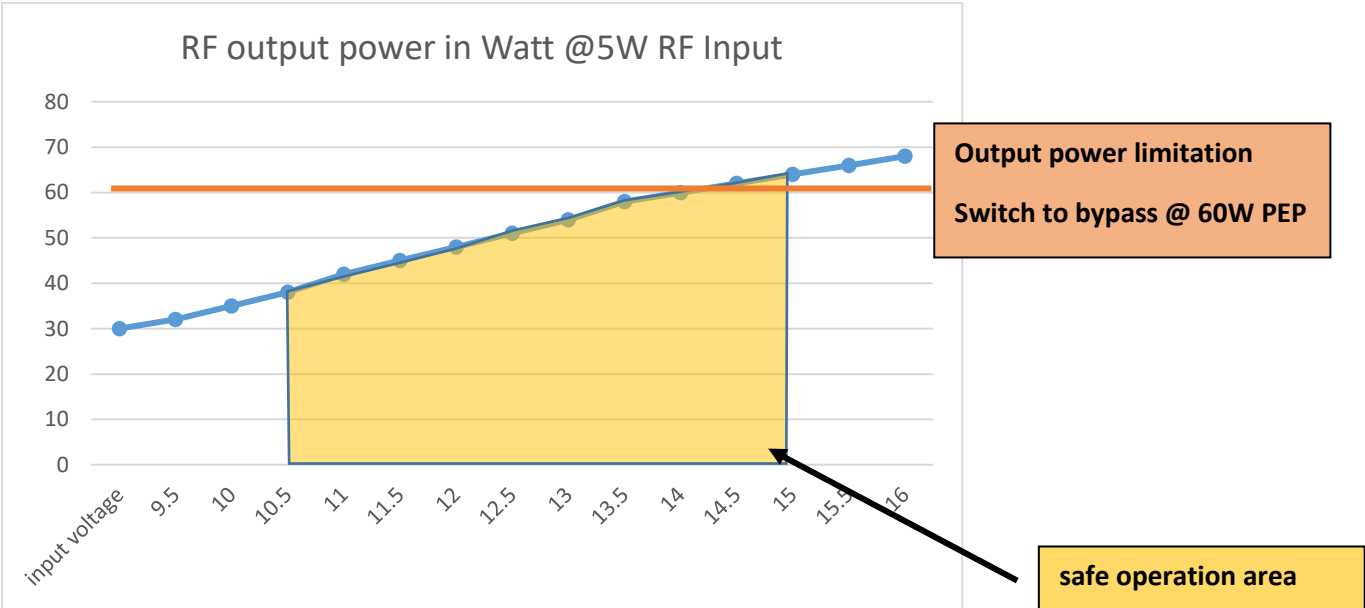
safety alters	LED <b>blinking</b>
Input <b>OR</b> output over power detected Input-Power >5W / Output-Power >60W safety shut-off (PA switch to bypass)	Blue, green, yellow, red
Temperature is between 60-70°C	yellow
Temperature is over 70°C safety shut-off (PA switch to bypass)	Yellow, red




# safety operating area SOA

RF output power vs. RF input power



RF output power vs. operating voltage input



-  **Overdriving the PA leads to the harmonic distortion exceeding the permitted limits.**
-  **The maximum output power is achieved with a matched antenna. If the antenna is not matched, tune the antenna to the right impedance with the integrated antenna tuner.**
-  **This safety operation area may violate other operating conditions e.g., transmit duty cycle limits. Please see 'operating modes and drive power'.**

## special transceiver characteristics (in manual modes)

Some transceivers have specific characteristics associated with the operation of peripheral devices. Known characteristics in connection with the operation of the PA500 are listed here.

### Yaesu FT817/818

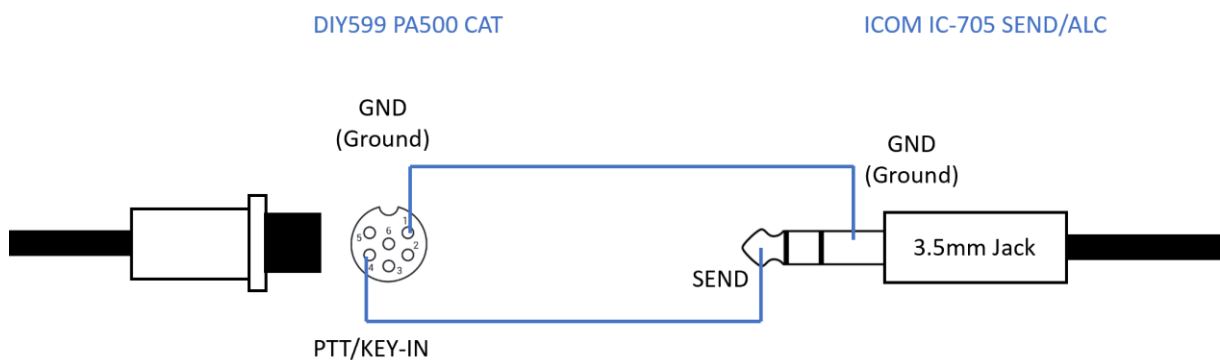
If the Yaesu FT817/818 is used with a CAT interface cable, the transceiver will not turn on if the PA500 has already been turned on. Therefore, make sure that the transceiver is always switched on first and then the PA500.

### ICOM IC-705

the IC-705 transceiver has several similar jacks. The SEND/ALC Jacks must be used for the connection with the PA500.

## Connection cable wiring (for manual control modes)

### ICOM IC-705



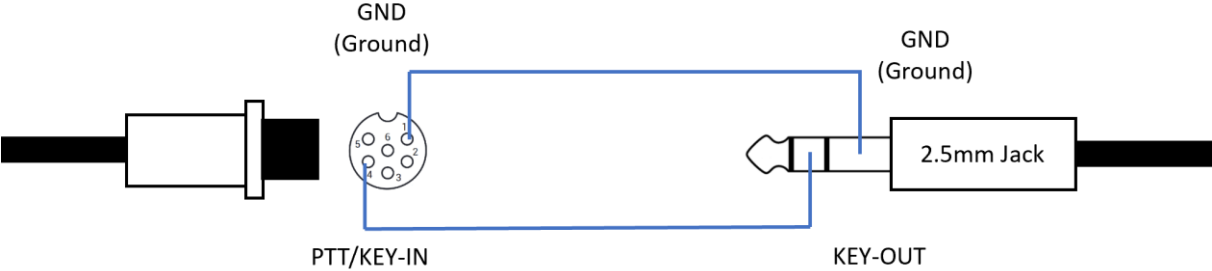
### ELECRAFT KX2



ELECRAFT KX3

DIY599 PA500 CAT

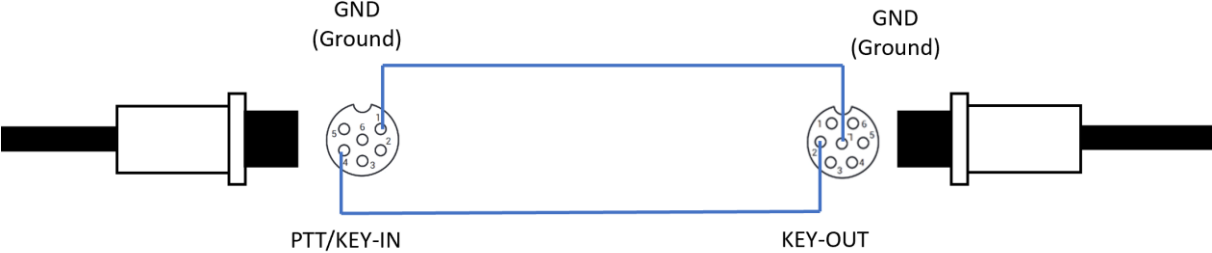
ELECRAFT KX3 ACC2



LAB599 TX-500

DIY599 PA500 CAT

Lab599 TX-500



# safety instructions

**The device can get very hot.** It must be operated in such a way that there are no heat-sensitive objects near the device. **Please ensure that the device is always well-ventilated during operation.** Please be aware that the device is still hot for a while after use. Please keep the device away from children, the device develops a temperature level which can cause burns to the skin. The device has an over temperature protection and will shut of when the device temperature reaches 70°C

## temperature and ventilation

**The device must be operated in such a way that ventilation is guaranteed at all times.** Please never expose the device to direct sunlight. External ventilation may be necessary in extreme operating conditions.

## EM interference

This equipment has been tested and found to comply with the defined limits for amateur radio equipment. This device is tested in a laboratory, all measurements were applied with suitable measuring devices. The device itself does not emit radio frequency energy to the antenna without a connected amateur radio transceiver. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy when it's connected to an amateur radio transceiver and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and effected receiver device.
- Reduce the output power until the device no longer interferes.
- Consult the dealer or an experienced radio/TV technician for help.

Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

CAUTION: Changes or modifications to this device, not expressly approved by DIY599 could void your authority to operate this device under compliance regulations.



**This device is for use by licensed radio amateurs only**

## grounding and ESD protection

A connected transceiver should be connected to ground to provide some protection against lightning and damage due to electrostatic discharge (ESD). When used in a building, the connected transceiver should also be connected to other building grounds.



**if the transceiver is not grounded, high voltage can be present on the chassis during RF transmission.**

## power considerations on the go

The "Buddipole POWERmini USB" is a pocket-sized 12 VDC portable DC power management system with built in solar controller that is particularly suitable for portable operations. This device can deliver up to 32A at 12V. this makes it a suitable device for supplying your transceiver and the PA500 with power on the go.

## device specifications

	PA500
Amateur Radio Bands	3.5 - 29.7 MHz (max. SWR 3:1)
max. PEP RF output power (FM/AM(SSB/CW)@ 12V	40W <sup>***</sup>
RF power gain	10dB-15dB
RF amplifier operation class	AB
Input impedance	50 Ohm
max. input drive level	5W <sup>*</sup>
Transceiver tune-up power (PA active)	1W-5W
Band coverage / frequency ranges	80m,40m,20m,17m,15m,12m,10m
Operating modes	SSB, AM, FM, CW, DIG
Harmonic distortion suppression below carrier	>43dB <sup>**</sup>
operating voltage	11-16.8V
max. power consumption (TX)	typ. 13.8V@8A
Power consumption (stand by)	typ. 13.8V@0.05A
Power consumption (sleep/off)	typ. 13.8V@0.01A
Control Interfaces	PTT/CAT/band-voltage
ATU Frequency range	3.5-30MHz
ATU Tuning range	16-500 Ohms
Tuner network type	6x5 L-match
RF-input connector type	BNC
RF-output connector type	BNC
Number of integrated L-pass band-filters	4
L-pass Band-Filter type	Chebyshev
Protective circuit	Temperature Input power Overcurrent
weight in kg/lbs	0.9 / 1.98
dimensions (HWD) in mm	30x207x90
Ambient operating temperature range	5°C - +40°C
max. device surface temperature	70°C

\* SSB only, see 'operating modes and drive power'

\*\* within the specified operating conditions, see 'operating mode and drive power'

\*\*\* 60W@16V operating voltage and peak drive power, this setting may violate other operating conditions



# GENERAL TROUBLESHOOTING

fault description	Possible reasons	solution
Unable to turn on your PA500	power cord is not properly connected /or no power from the source	Connect power source correctly to the device
	power source is not capable to deliver the power	use proper power source
	internal fuse is open circuit	Device need to be repaired
Antenna tuning function does not work / tuner does not tune	No antenna connected	Connect a proper antenna usable for the operating frequencies of the PA500
	Antenna Tuner is configured into a manual-mode	Set it to auto-mode Or trigger a manual tuning event
	Antenna is already matched	-
No transmission / no amplification	Device in in BYPASS Mode	Set the device into TX Mode
	The Bandpass filter setting does not fit to the TX frequency	Set the correct filter for the TX frequency to be used
	No TX-Power from the Transceiver,	Check your Transceiver and connection
	Transceiver in SSB (no carrier)	Check your Transceiver and connection



**When the PA500 current draw is too high (more than 15A), or a short circuit occurs, the internal fuse may blow. The unit will then no longer turn on. The device needs a service.**



**Do not allow the maximum output power of the amplifier to exceed 40 W.  
The PA switches to bypass mode when the maximum output power is exceeded by 1 dBm**

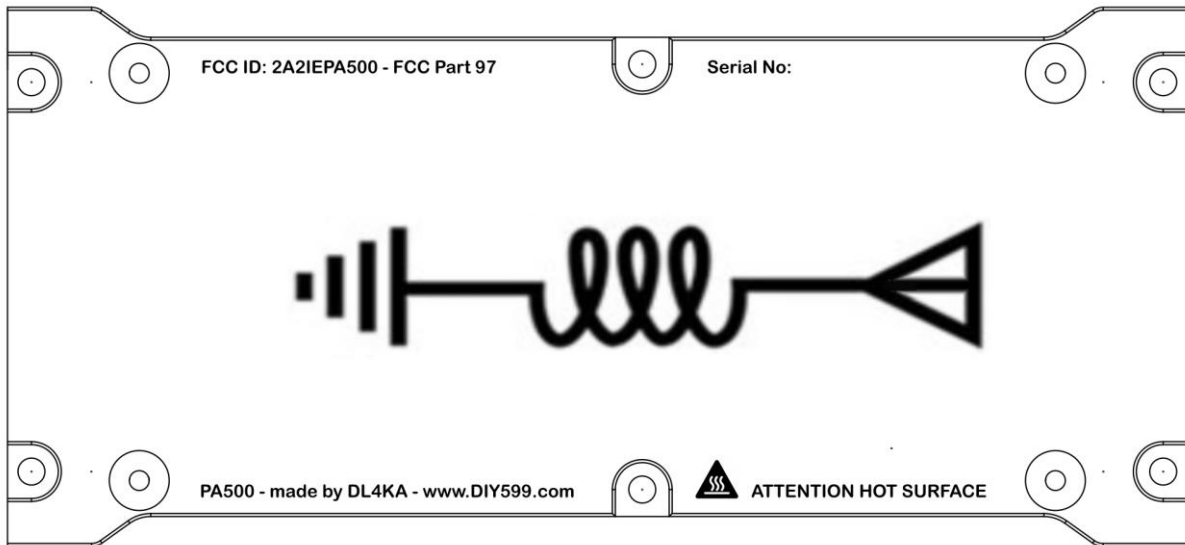


**Using the PA500 at high power levels for extended periods can lead to overheating and potential damage to the PA stage.**

## AFTER-SALES SERVICE POLICY

If this kit is bought in the European union, this product has a limited one-year warranty effective from the date of purchase. This warranty covers only manufacturing and parts defects. It does not cover damage caused by lightning, excess voltage on the power supply, accidental damage or purposeful damage or misuse. If the product needs warranty repair within two weeks of receiving the product, DIY599 will pay for the shipping both ways. After two weeks DIY599 will pay only for return shipping. If the product is not covered under warranty, the customer pays for shipping both ways plus the cost of the repair.

## Device LABEL and ID location



## WARRANTY LIMITATIONS

**Any of the following will void the warranty applicable to the product and its accessories:**

- A. Modification-, removal-, or maintenance of the internal circuitry, without permission and authorization;
- B. Unauthorized change of product's embedded software;
- C. Immersion in liquid or signs of external damage;
- D. Warranty period expired;
- E. Product's serial number is missing, torn or blurred so we cannot determine if the radio is under warranty;
- F. Product was not bought from DIY599 or authorized distributor of DIY599.

**None of the following conditions, are covered by the warranty:**

- A. Damage caused by improper use by the user ;
- B. Damage caused by an accident ;
- C. Damage due to incorrect testing, maintenance, debugging, or other changes ;
- D. Damage is not caused by the material or the quality of production ;
- E. Damage to the shell or other external components due to improper use.

**Contact us for service:** [service@DIY599.com](mailto:service@DIY599.com)

# Note Amateur Radio Operation

DIY599.com is obligated as a manufacturer of amplifier devices to draw attention to the following legal provisions:

The following restrictive conditions apply:

This device is intended for use by radio amateurs within the meaning of the law on amateur radio in the valid amended. During operation of the device, the amateur radio law and supplementary laws and regulations must be observed.

## WARRANTY TERMS

For amateur radio power amplifier PA500 legal guarantee determinations apply only if the device is operated in a manner corresponding to its intended use. This includes in particular the compliance with the operating limits mentioned in this manual.

## DISCLAIMER of LIABILITY

All PA-500 specifications and descriptions are based on the latest information available at the time of this document's printing. As we are always striving to improve and update our products, ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE and DIY599 reserves the right to make changes and improvements at any time without further notice or obligation to notify any person or organization of such revisions or changes, made in order to improve the reliability, function, quality and design and/or performance of the PA500. Further, this Manual is provided "as is" and DIY599 shall not be liable for possible errors contained herein.

If there are any questions, please contact DIY599.com as follows:

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