

# Entry Level AO-40 Capable Satellite Stations

Howard Long G6LVB

# Goals

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- **Eliminate common misconceptions about satellite operations**
- **Build a reliable two-way voice Ground Station for c£300 (US\$430)**
- **No special knowledge techniques or tools required**
- **Something the neighbours will like**

# Common myths and excuses about AO-40

- **The equipment's too expensive**
- **You need specialist microwave skills**
- **You need expensive specialist tools and test equipment**

# Description

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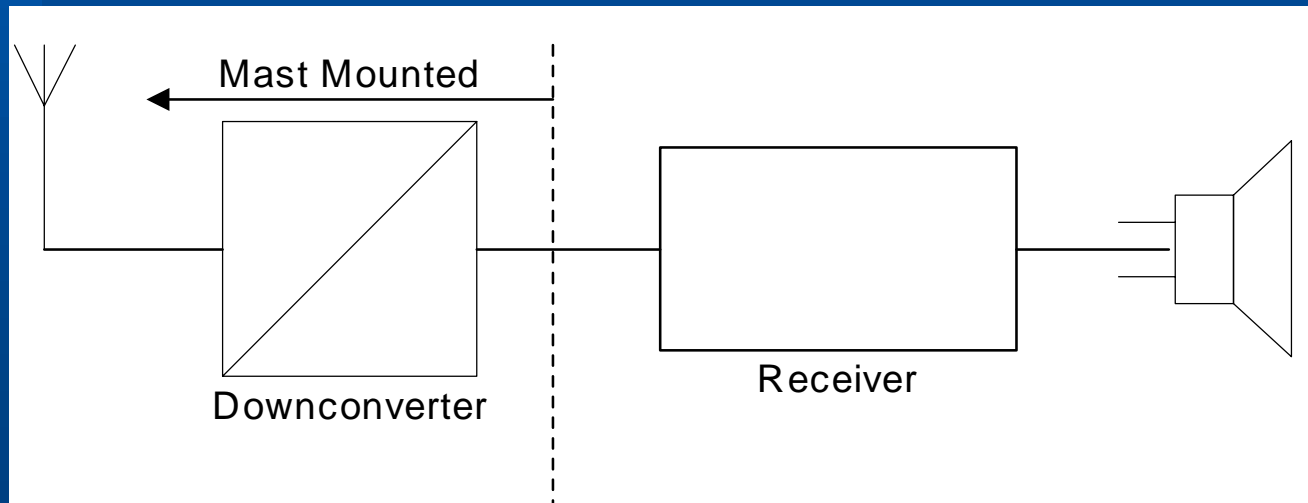
- Equipment to receive from AO-40
- Equipment to transmit to AO-40
- Putting it together

FOR MORE INFO...

<http://www.g6lvb.com>

# Equipment to Receive AO-40

- Antenna
- Downconverter
- Receiver



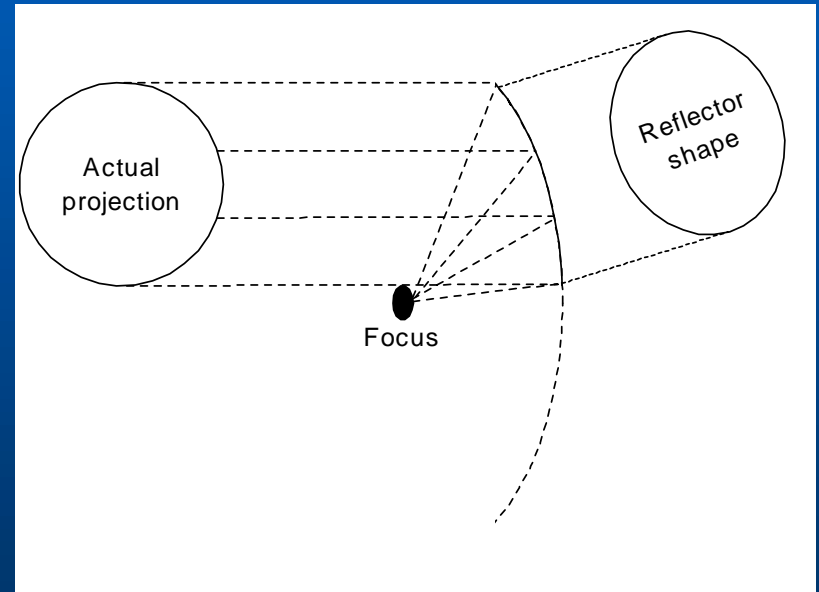
# Receive Antenna

- 60cm TVRO Offset Fed Dish
- G3RUH feed
- 2 hours
- Cost: £0 (\$0)



# Offset fed dishes

- Feed does not obscure radiated beam
- Slightly elliptical
- Section of a full-size parabolic dish



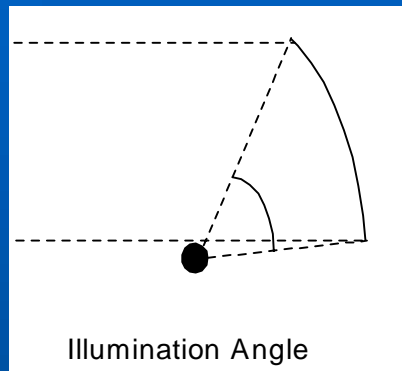
# Feeding offset fed dishes I



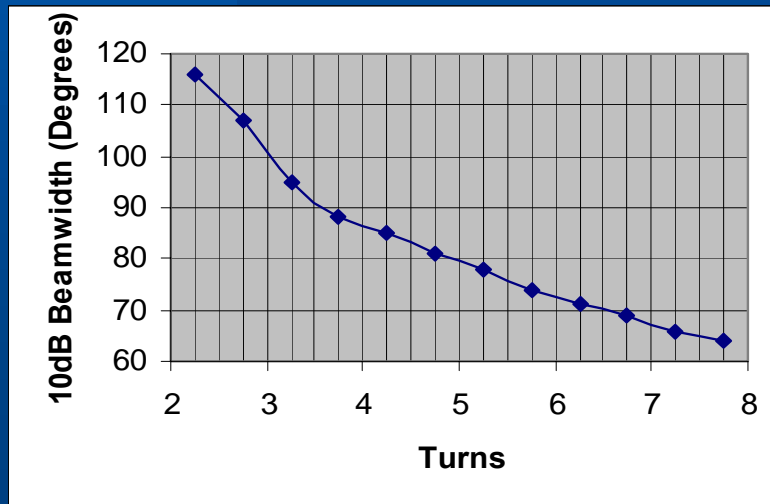
- **Modified G3RUH feed (more turns, smaller beamwidth), very easy to fabricate**
- **Put feed phase centre at dish focus**
- **$\lambda/4$  transformer matching helix to 50 $\Omega$**



# Feeding offset fed dishes II



- Match 10dB feed beam width to illumination angle
- Easier matching if odd number of  $\lambda/4$  turns (including match)



# Downconverter

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- **Convert 2.4GHz to an Intermediate Frequency (IF)**
- **Cheap TV Receive converters can be used**
- **Modifications can be very simple**
- **Cost: £59 (US\$84) including modifications**

# AIDC TransSystem

## Downconverter Modifications

- **Crystal for 144MHz IF**
- **Snip the  $\lambda/4$  stub**
- **Replace dipole/reflector feed with N-adapter**
- **New filter to remove second IF image**

# Receiver

<b>Name: Simon GM4PLM</b>		<b>Email: <a href="mailto:simon@creoch.freemove.co.uk">simon@creoch.freemove.co.uk</a></b>
04 June 2001 - 20:37		
<b>Make/Model: Yaesu/FT-757 GXII</b>		
HF Transceiver and General Coverage Receiver. Narrow CW Filter Fitted. Complete with Manual and Technical Supplement £325.00 Lots of other stuff surplus, see full list at <a href="http://www.qsl.net/g4ujs">http://www.qsl.net/g4ujs</a>		
<b>Name: Bob</b>		<b>Email: <a href="mailto:g4ujs@qsl.net">g4ujs@qsl.net</a></b>
15 May 2001 - 20:15		
<b>Make/Model: Yaesu/FT-790R/FT-290R</b>		
FT-790R, works fine, case bit tatty, Boxed, manual £90, FT-290R Boxed, manual £100		
<b>Name: Adrian</b>		<b>Email: <a href="mailto:ade@50mbz.org">ade@50mbz.org</a></b>
23 May 2001 - 12:02		
<b>Make/Model: Yaesu/FT-8000</b>		
Yaesu FT-8000 dual band 2m/70cm mobile. Spec as FT-8100 but fixed fascia. VGC, boxed, manual. £175 ovno		
<b>Name: Julian</b>		<b>Email: <a href="mailto:yhf@btinternet.com">yhf@btinternet.com</a></b>
20 May 2001 - 21:58		

- Must be able to resolve SSB at the Downconverter IF (144MHz)
- Must be cheap
- FT-290R MK-I £100 (US\$142)

# Testing the Receiver configuration

- **Pointing the feed (without the dish) to the ground should show increase in audible noise.**
- **With the feed on the dish there will be a small increase in noise if you point the dish at the sun.**
- **Point the dish at AO-40 and you will hear telemetry and be able to tune the downconverter LO**

# Equipment to Transmit to AO-40

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- **What band?**
- **How much power for reliable voice communications?**
- **Balancing Transmitter Power and Antenna Gain**
- **What Transmitter?**
- **What Amplifier?**
- **What Antenna?**

# Transmitter

- Need to transmit SSB on 435MHz
- Must be cheap
- FT-790R MK-I £90 (US\$128)

MIS LYONCHLINE	
All Areas	
<b>Name:</b> Simon GM4PLM	<b>Email:</b> <a href="mailto:simon@creoch.freemove.co.uk">simon@creoch.freemove.co.uk</a>
04 June 2001 - 20:37	
<b>Make/Model:</b> Yaesu/FT-757 GXII	
HF Transceiver and General Coverage Receiver. Narrow CW Filter Fitted. Complete with Manual and Technical Supplement £325.00 Lots of other stuff surplus, see full list at <a href="http://www.qsl.net/g4ujs">http://www.qsl.net/g4ujs</a>	
<b>Name:</b> Bob	<b>Email:</b> <a href="mailto:g4ujs@qsl.net">g4ujs@qsl.net</a>
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<b>Name:</b> Adrian	<b>Email:</b> <a href="mailto:adn@50mhz.org">adn@50mhz.org</a>
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<b>Make/Model:</b> Yaesu/FT-8000	
Yaesu FT-8000 dual band 2m/70cm mobile. Spec as FT-8100 but fixed fascia. VGC, boxed, manual. £175 ovno	
<b>Name:</b> Julian	<b>Email:</b> <a href="mailto:vhf@btinternet.com">vhf@btinternet.com</a>
20 May 2001 - 21:58	

# Amplifier



- FT-790 1 watt output inadequate, so need some more power
- Must be cheap...
- Second user 50W amplifier £78 (US\$111)



# Transmitting Antenna I

- Small
- 435MHz band
- >10dBic gain
- 3 hours
- Cheap £22 (US\$31) including power splitter



# Transmitting Antenna II



- Power splitter -  
Two  $\lambda/4$  pieces of  
RG-59
- Orthogonal  
elements offset by  
 $\lambda/4$

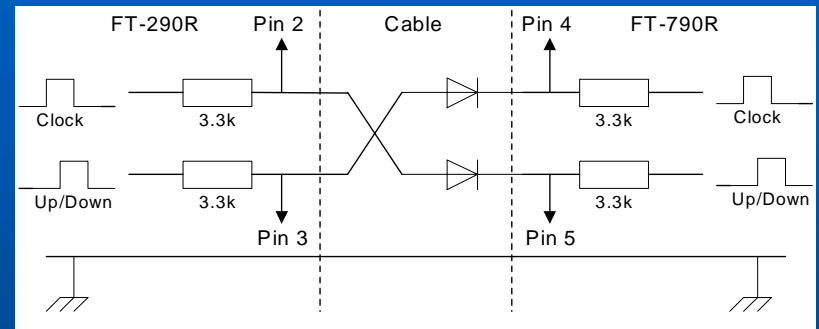
# Putting it together

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- **Transponder passband tracking**
- **Computer Doppler correction**
- **Where's the rotator?**

# Transponder Passband Tracking

- Old radio = no features?
- Or...
- Old radio = easily modified?
  - Rotary encoder  
KISS modification



# Computer Doppler Correction

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- **In practice, for an entry level system this is optional**
- **Facilities of InstantTune with InstantTrack allow mic button up/down doppler correction**

# Where's the rotator?

- Az-El rotator would completely blow budget
- 'Armstrong' technique perfectly acceptable!



# What do the neighbours think?



- Not any different to a conventional UHF TV antenna and TV Sat Dish
- Point it out of your window

# AO-40 – Apartment Dwellers’ Dream

- Antennas small enough to put on balcony...
- ...or underground!





# What 'special' skills and equipment did I need?

- **Ability to use**
  - **Soldering Iron**
  - **Screwdriver**
  - **Hack saw**
  - **Drill**
  - **Ruler**
  - **Magnetic Compass**

# Did we hit budget?

- £349... not quite
- US\$498
- EUR566
- ¥61586
- FRF3717
- DEM1108
- CAD766
- AU\$980

Description	£
TransSystem Rx Converter, N Type adapter, 2m Xtal, Filter + PCB	59
FT-290 2 <sup>nd</sup> Hand	100
FT-790 2 <sup>nd</sup> Hand	90
50W 70cm Amplifier 2 <sup>nd</sup> Hand	78
Dish + Feed	0
70cm Yagi Elements	10
70cm Yagi Boom	2
70cm Power Splitter	10
<b>Total</b>	<b>349</b>