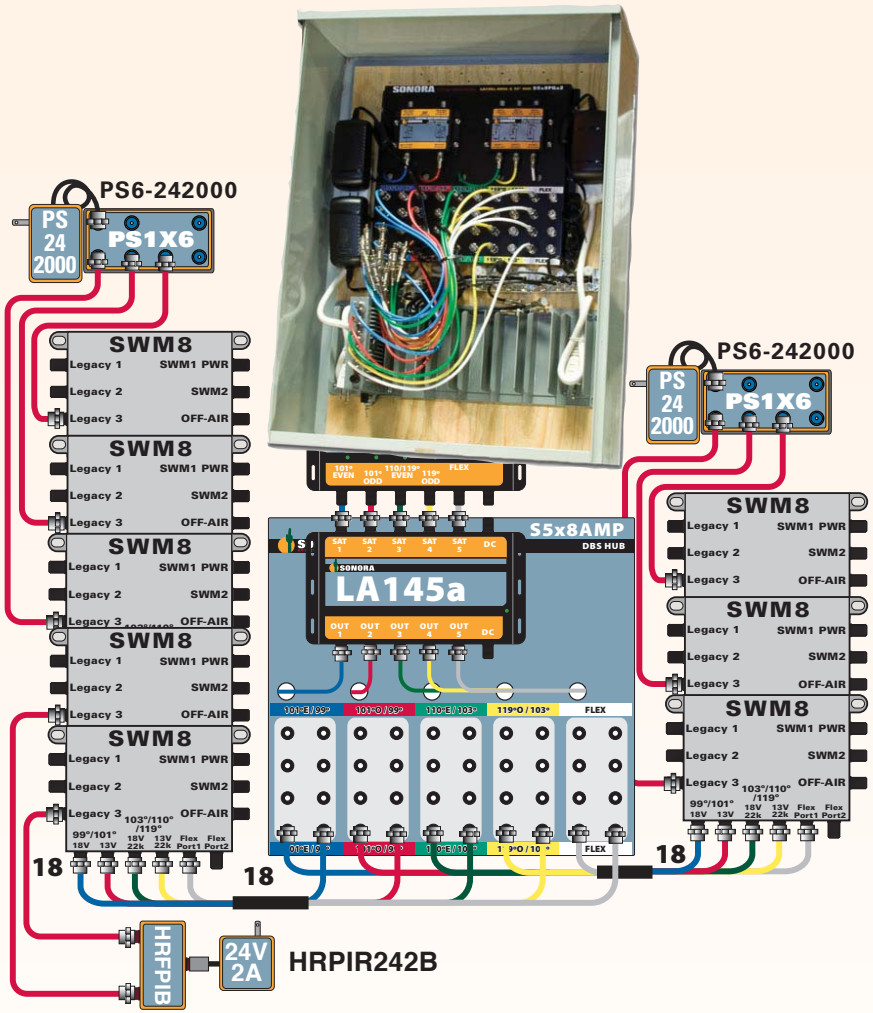

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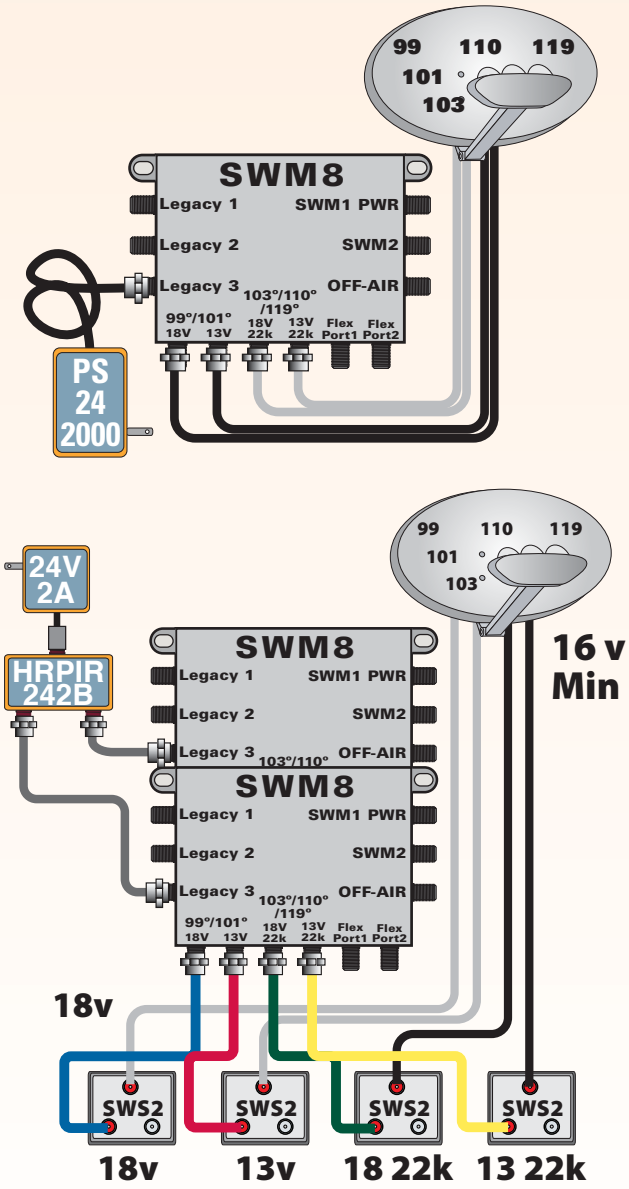


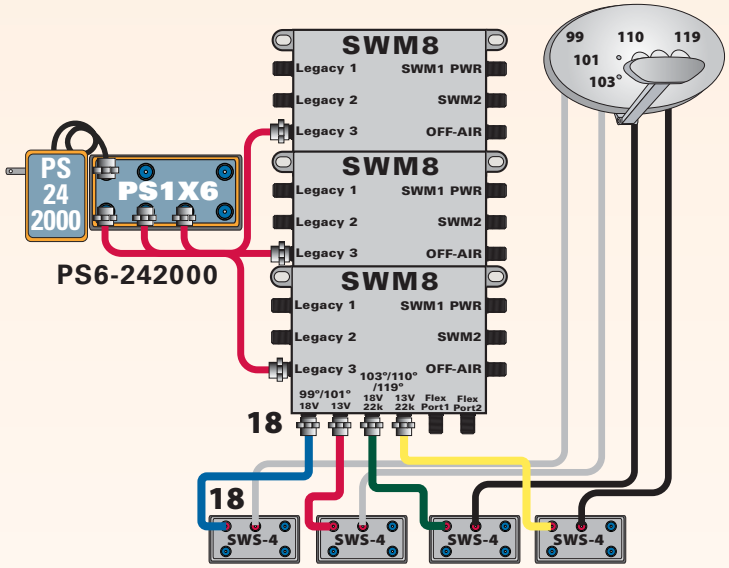
SWM8 & AU9S Powering

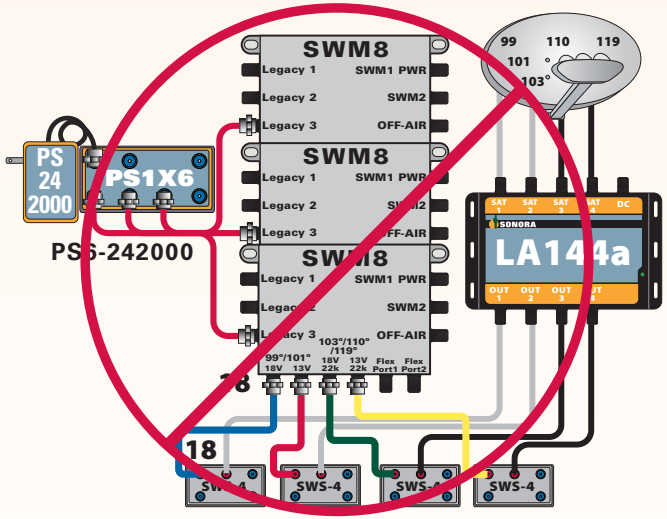
- Model **SWM-8** current draw was measured:
  - 29 V = 324 mA
  - 24 V = 385 mA
  - 20 V = 460 mA

- Model **AU9S** employs current management circuitry to minimize the current carried in any single coax: (500 mA max)
  - 18 V = 200 mA
  - 18 V 22k = 200 mA
  - 13 V = 50 mA
  - 13 V 22k = 50 mA

- (Top) **PS242000** is a 24V, 2 Amp power supply capable of powering (1) SWM8 and AU9S. Legacy port 3 is used to insert power. (385 mA + 500 mA = 885 mA)

- (Bottom) Model **HRPIR242B** is a 24V, 2 Amp, bidirectional power inserter capable of powering (2) SWM8 switches and a AU9S. (385 mA + 385 mA + 500 mA = 1.27 A)

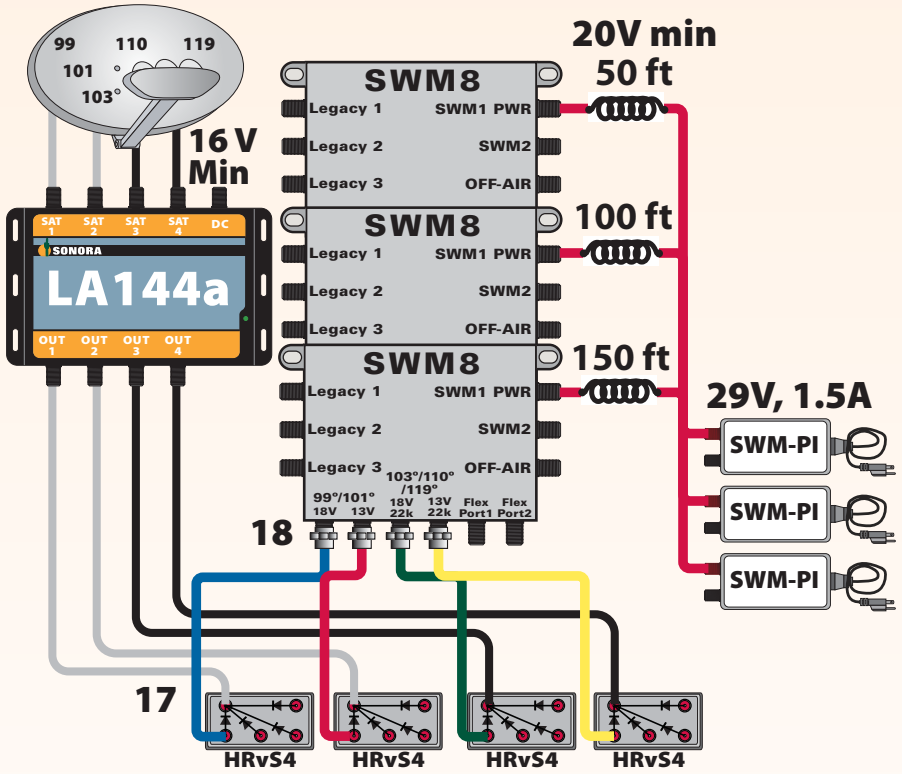




Multiple SWM8 Powering

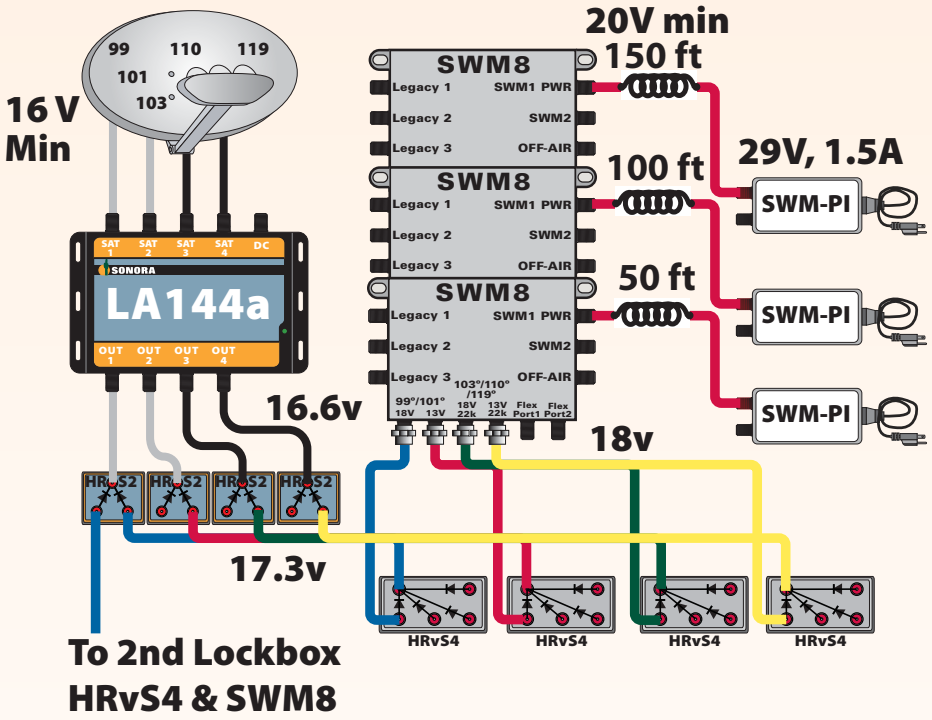
- (Top) Model **PS6-242000** is a 24V, 2 Amp, 6-port power supply capable of powering (3) **SWM8** switches.
  - (3) x 385mA = 1.2 A
  - (3) x 385mA + AU9 (0.5A) = 1.7 A
  - (4) x 385mA = 1.54 A
  - (5) x 385mA = 1.95 A
  - (6) x 385mA = 2.39 A

- Line amplifiers are often used to offset the cable and splitter loss. Each polarity of Sonora's **LA144a** amplifier draws 70 mA.
  - (4) x 70mA = 0.28 A
  - (3) x 385mA + 0.28A + (0.5A) = 1.98 A



Multiple SWM8 Remote Powering

- System operators often find no AC power available at the SWM lock box.
- Model **SWMPI** with 29V and 1.5 Amp of current is used in customer's units to remotely power the SWMs and AU9S.
  - (1) SWM8 @ 385 to 460 mA
  - (4) LA141a @ 70mA = 280 mA
  - (1) AU9S @ 500 ma
  - Total = 1.2 A @ 29V to SWM8
  - Total = 1.3 A @ 20V to SWM8
- What is the voltage at the SWM8's assuming 50, 100 and 150 feet of RG-6 solid copper?
  - 50 ft = 29V - (2 ohm x 1.2A) = 26.5V
  - 100 ft = 29V - (4 ohm x 1.3A) = 24V
  - 150 ft = 29V - (6 ohm x 1.3A) = 21V
  - 200 ft = 29V - (8 ohm x 1.3A) = 18V
- How far can the AU9 be from the SWM's?
  - More Later on V = I x R



(2) Lock-box Remote Powering

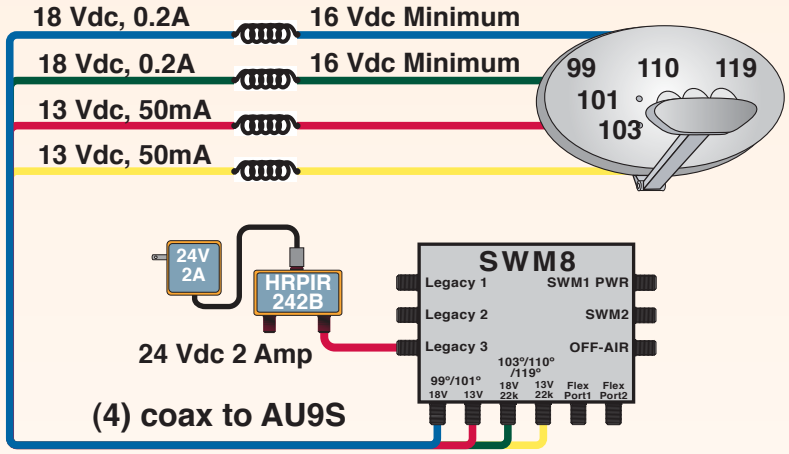
- System operators often find no AC power available at the SWM lock-box. In addition, (2) lock-boxes are being served by a single dish.

- Model **SWMPI** with 29V and 1.5 Amp of current is used in customer's units to remotely power the SWMs and AU9S.
  - (1) SWM8 @ 385 (29V) to 460 mA (20V)
  - (4) LA141a @ 70mA = 280 mA
  - (1) AU9S @ 500 ma
  - Total = 1.3 A @ 20V to SWM8

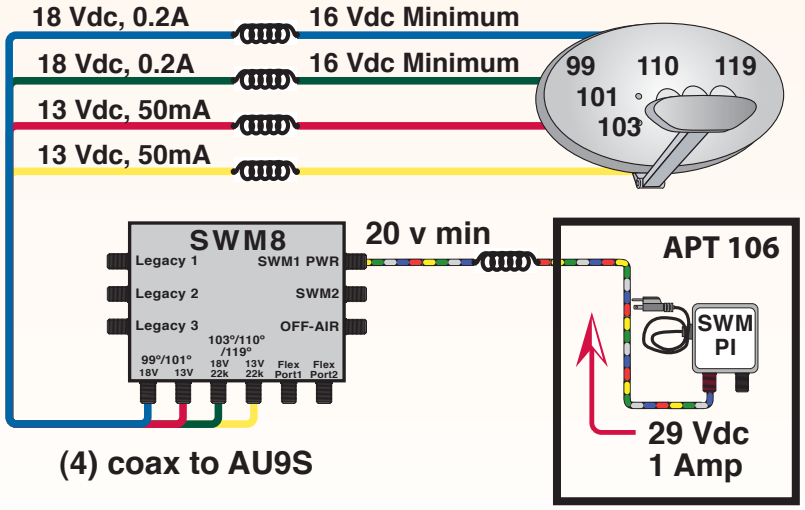
- What is the voltage at the input of the HRvS2 diode steered splitter? Each splitter in series looses 0.7 volts.
  - Just 16.6 volts is available to get to the AU9S dish

- How far can the AU9 be from the SWM's?
  - More Later on V = I x R

Lockbox SWM8 Powering



Apartment SWM8 Powering

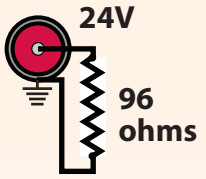


SWM8 DC Coax Loss

- **V = I x R** where **V** = voltage drop, **I** = total current and **R** is equal to total resistance.

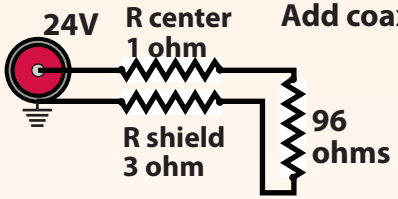
- The top installation has (4) coax cables from the **AU9S** to the indoor SWM8. The 18v and 18 v 22kHz lines carry 200 mA of the 0.5 Amp current for the dish.
  - 200 mA x 4 ohms = 0.8 V loss per 100 ft
  - @ 200 feet the loss would be 1.6 V
  - At the AU9S: 18v - 1.6v = **16.4 V**

- The bottom installation is powered from subscriber's apartment. One Amp of current is carried on the single coax to the SWM8.
  - **Solid Copper Center Conductor**
    - 1A x 4 ohms = 4 V loss per 100 ft
    - @ **200** feet the loss would be **8V**
    - At the SWM8: 29v - 8v = **21 V**
  - **Copper covered Steel**
    - 1A x 8 ohms = 8 V loss per 100 ft
    - @ **100** feet the loss would be **8V**
    - At the SWM8: 29v - 8v = **21 V**



Power to Dish creates a current

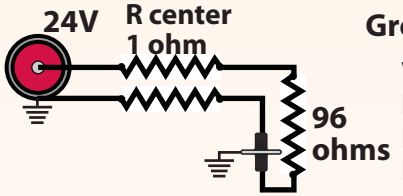
V = I x R
I = V / R
I = 24 / 96
I = 0.250 Amp



Add coax between Power & Dish

V = I x R
I = V / R
I = 24 / 100
I = 0.24 Amp

V @ Dish
V = I x R
V= .24 x 96
V = 23 V



Ground Coax @ Dish

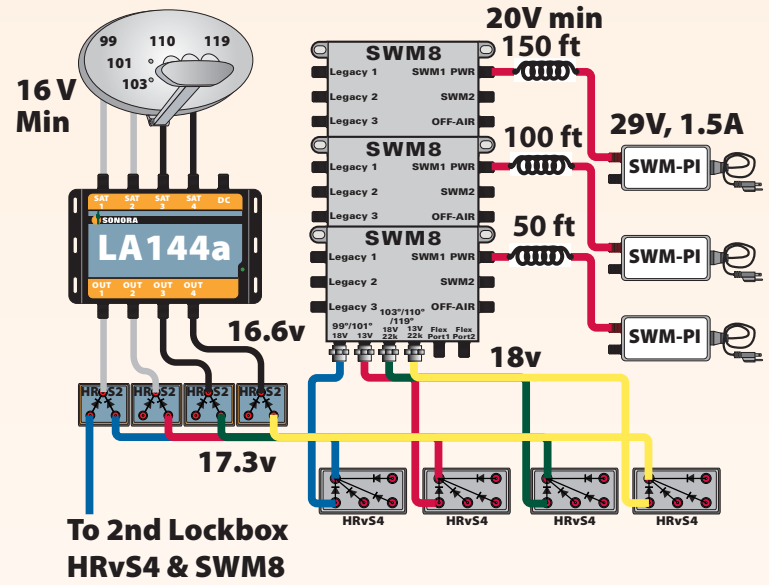
V = I x R
I = V / R
I = 24 / 97
I = 0.247 A

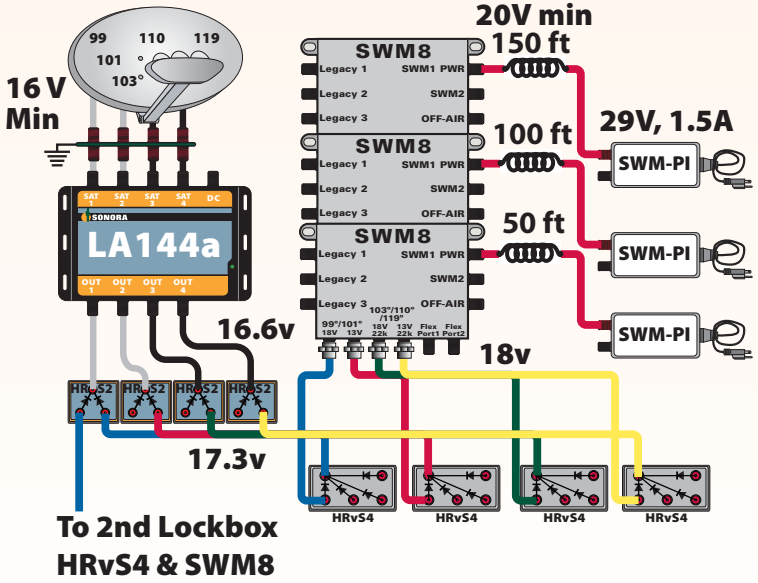
V @ Dish
V = I x R
V= .247 x 96
V = 23.7 V

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths		Standard Unit Weight		Conductor (stranding) Diameter Nom. DCR	Nominal Core OD		Shielding Materials Nom. DCR	Nominal OD	
			Ft.	m	Lbs.	kg		Inch	mm		Inch	mm
Series 6 • 18 AWG	Solid .040″ Bare Copper or Bare Copper-covered Steel Conductor (see below) • Duobond											
Gas-injected Foam Polyethylene Insulation • PVC Jacket	(Black, Gray, White or Neutra											
80°C	**1829A**	NEC: U-1000 CATV CM 1000 CEC: CM	† U-304.8 † 304.8	29.0 29.0	13.2 13.2	18 AWG (solid) .040 ″ BCCS 28.0 Ω/M′ 91.9 Ω/km	.180	4.57	Duobond II* + 60% Aluminum Braid 9.0 Ω/M′ 29.5 Ω/km	.270	6.86	75	83%
† Final put-up length may vary ±10% for spools, ±5% for unreel cartons.												
80°C	**1829AC**	NEC: U-1000 CATV CM 1000 CEC: CM	▲ U-304.8 ▲ 304.8	27.0 27.0	12.3 12.3	18 AWG (solid) .040 ″ BCAC 6.4 Ω/M′ 21.0 Ω/km	.180	4.57	Duobond II* + 60% Aluminum Braid 9.0 Ω/M′ 29.5 Ω/km	.270	6.86	75	83%

Coax Loop Resistance

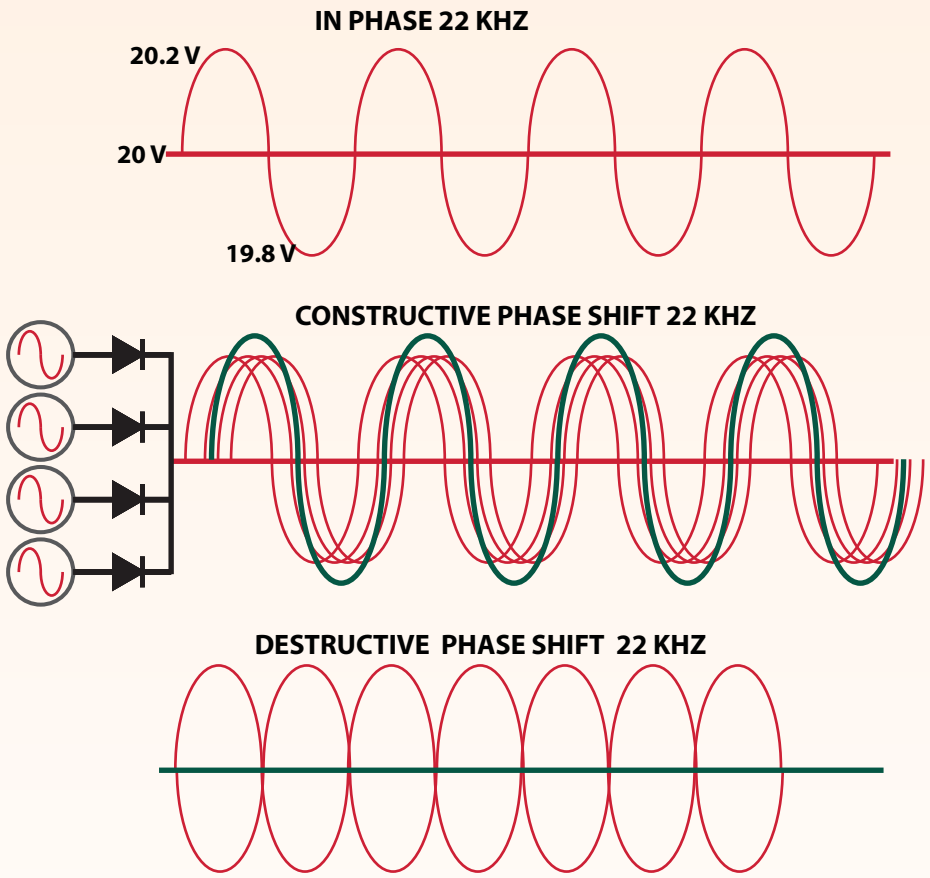
- Connecting an LNB right at the power inserter provides the full 24 volts to the LNB.
- Moving the LNB 100 feet away with RG-6 adds resistance to the center conductor and the shield. Voltage must travel to the LNB and return to ground. One volt is lost.
- Placing a ground block at the Dish eliminates the need for current to return to the power inserter. (Ground block must be well grounded).
- Not all coax has the same characteristics. Belden model **1829A** is copper coated steel and model **1829AC** is solid copper center conductor with a center resistance of 0.6 ohms per 100 feet and a shield resistance of 0.9 ohms per 100 feet.





Remote Powering and Grounding

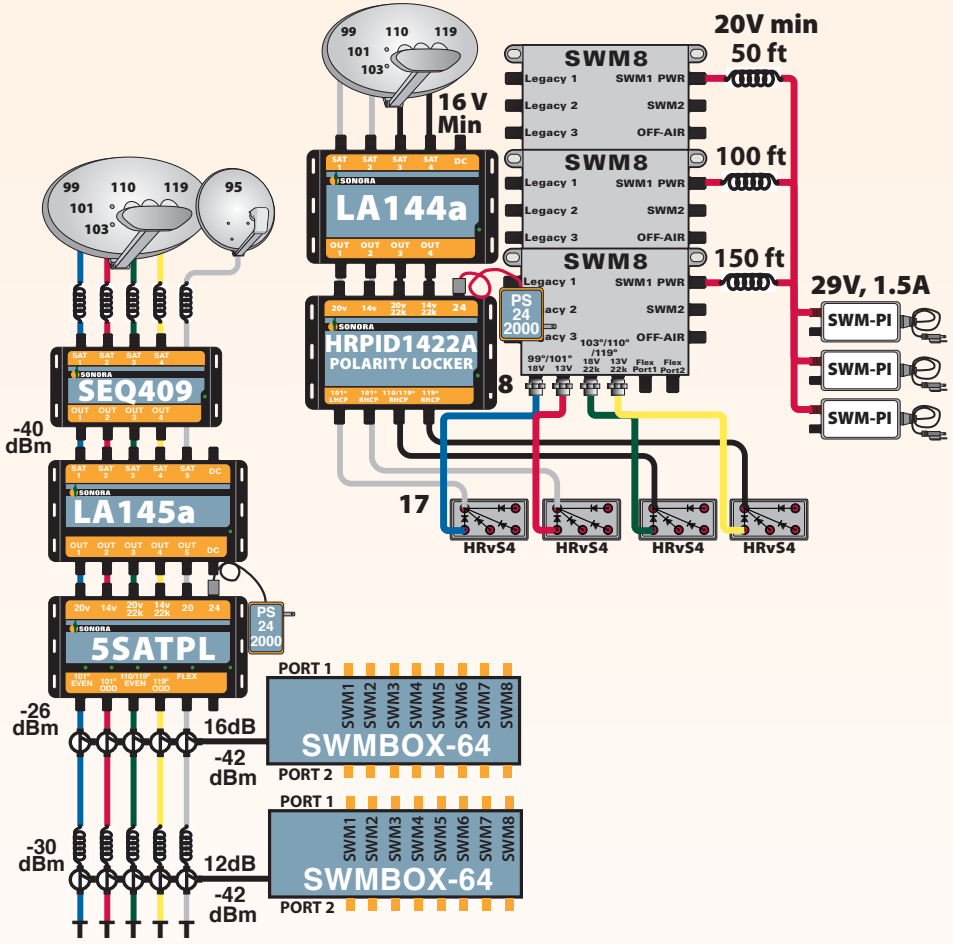
- Previously we determined the **SWMPI** had sufficient current to handle the equipment on the top left.
- At issue was the ***16.6*** volts available at the HRvS2 input to power the AU9S. Could that reach the AU9S at greater than ***16 V***?
- Assume a loop resistance of 4 ohms with 1 ohm center conductor and 3 ohms shield. (200 mA x 4 ohms = **0.8V drop**...to much loss)
- Placing a well grounded (4) coax ground block at the dish reduces the loop resistance to 1 ohm. (200 mA x 1 ohms = ***0.2 V drop***) Now **16.4 volts** gets delivered to the AU9S.



Multiple 22 kHz Signals

- What is the possible affect of combining the multiple SWM LNB power and 22 kHz tones?
- Some strange field problems can be attributed to 22 kHz phasing. Multiple 22 kHz signals when combined can create constructive and destructive interference.
- In-phase combining will increase the amplitude to the 22 kHz signal as indicated by the center green waveform.
- 180º out of phase combining will reduce the 22 kHz signal to zero!
- the following web location has a live demonstration on the affects.

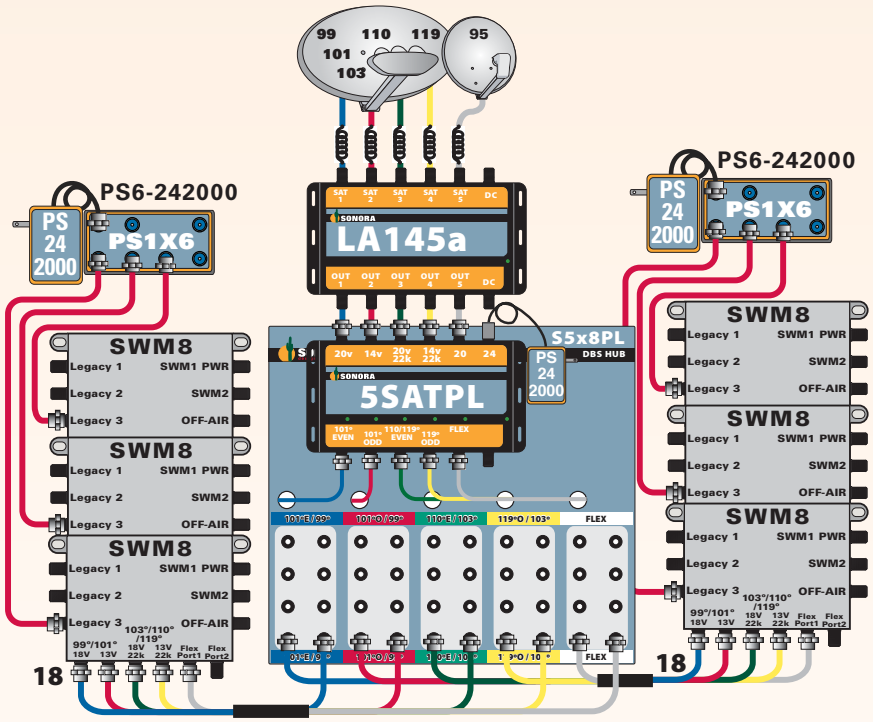
http://www.kettering.edu/~drussell/Demos/superposition/superposition.html



Polarity Locking, 22 kHz Blocking

- Models **HRPID1422A** and **5SATPL** generate stronger voltage and tone signals and block voltages and tones generated by SWM8 switches.

- The AU9S LNBs includes polarity switching multi-switches. Voltages and tones generated by the polarity locker powers and locks the dish to produce outputs, color coordinated with the coax jumpers used to configure systems.
  - 20 V..... blue..... Odd 99° & 101°
  - 14 V..... red..... Even 99° & 101°
  - 20 V & 22k.....green..... Odd 103° & 119°
  - 14 V & 22k.....yellow..... Even 103°, 110°/119°
  - 20 V.....white..... Odd 95°

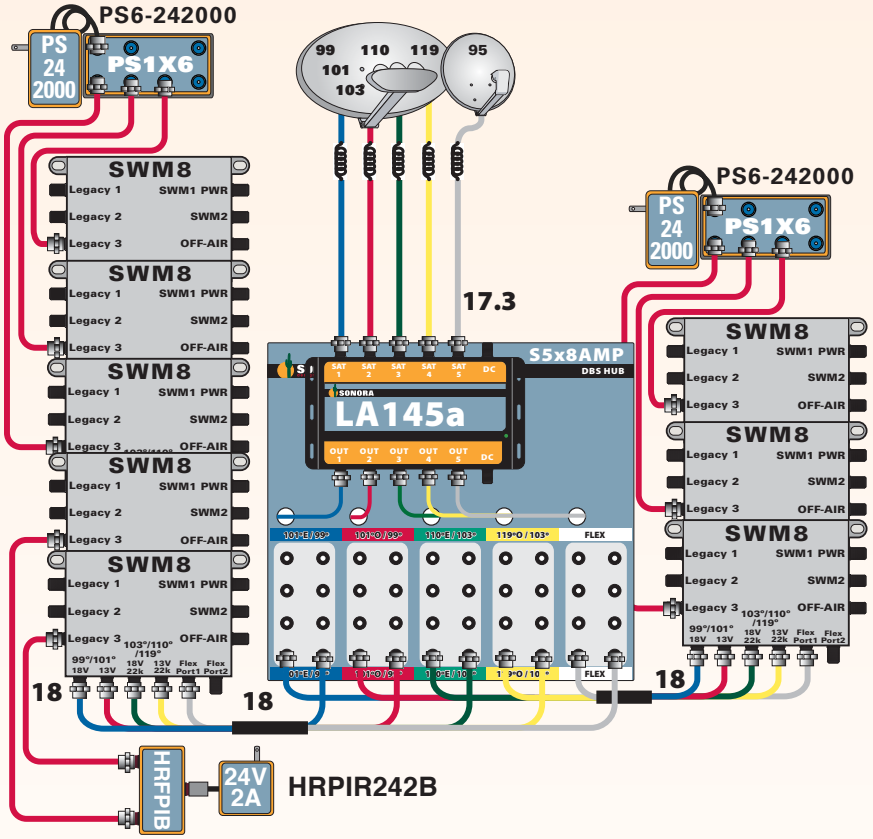


Polarity Locking Hubs

- Model **S5x8PL** is an (8) switch hub that generates voltage and tones to power and lock an AU9 and 95º LNB. It blocks voltages and tones generated by SWM8 switches.

- The system illustrated provides unity gain distribution of the 99º, 101º, 103º, 110º and 119º polarities. Model **LA145a** is a 14 dB gain amplifier powered by the **5SATPL**.

- Model **PS6-242000** is a 24V, 2 Amp, 6-port power supply capable of powering (4) **SWM8** switches. (The **5SATPL** takes care of the dish powering.)
  - (3) x 385mA = 1.2 A
  - (4) x 385mA = 1.54 A



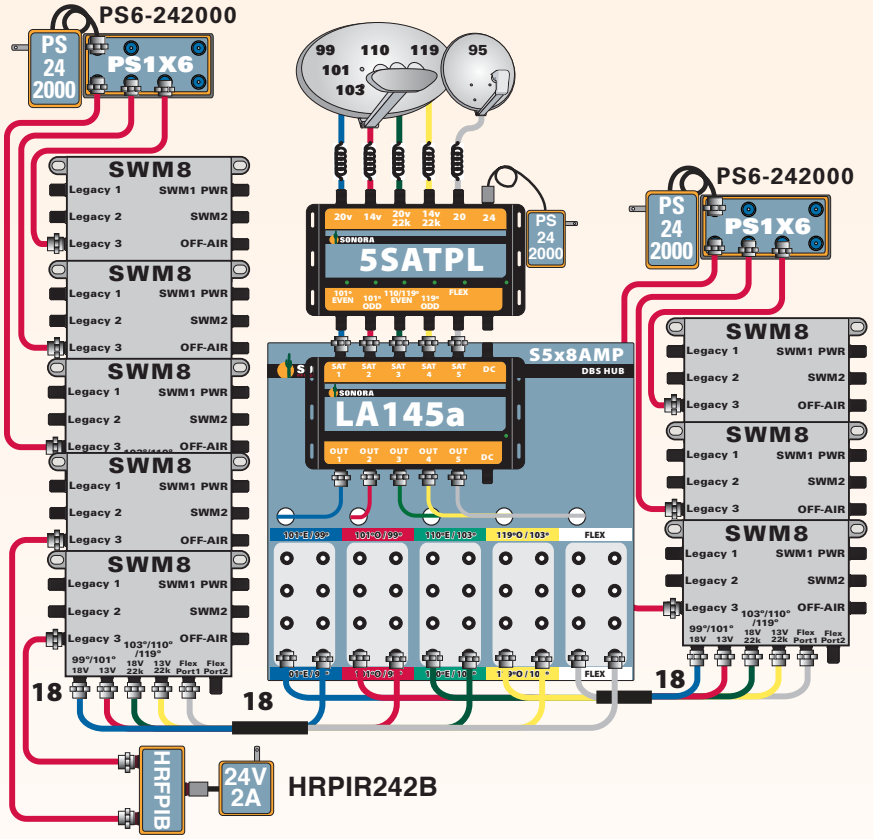
Unity Gain Hubs, Option A

- Model **S5x8AMP** is an (8) switch hub that passes voltages and tones generated by SWM8 switches.

- While this was not our intended use for this hub, several hundred of these systems have been deployed in this manner by a larger operator in our area. The key to successful operation is power management.

- Model **HRPIR242** is a 24V, 2 Amp, 2-port power inserter capable of powering (2) **SWM8** switches, the hub and an AU9S & 95º LNB.
  - (2) x 385mA = 0.77 A (switches)
  - (5) x 70mA = 0.35 A (hub)
  - 0.5 A + 0.15A = 0.65 A (LNBs)
  - Total = 1.77 A

- Model **PS6-242000** is a 24V, 2 Amp, 6-port power supply capable of powering (3) **SWM8** switches and an AU9S.
  - (3) x 385mA = 1.2 A



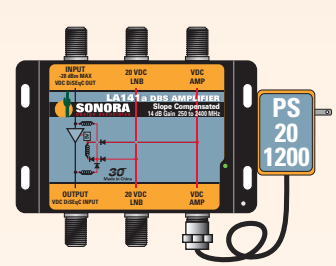
Unity Gain Hubs, Option B

- Model **S5x8AMP** is an (8) switch hub that passes voltages and tones generated by SWM8 switches.

- Inserting model **5SATPL** between the dish and hub relieves the switches from powering the dish.

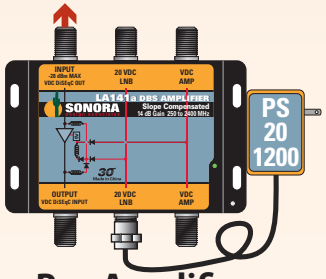
- Model **HRPIR242** is a 24V, 2 Amp, 2-port power inserter capable of powering (2) **SWM8** switches, the hub and an AU9S & 95º LNB.
  - (2) x 385mA = 0.77 A (switches)
  - (5) x 70mA = 0.35 A (hub)
  - Total = 1.12 A

- Model **PS6-242000** is a 24V, 2 Amp, 6-port power supply capable of powering (3) **SWM8** switches and an AU9S.
  - (3) x 385mA = 1.2 A



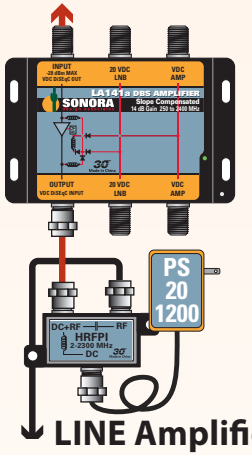
Node Amplifier

NO DC OUT



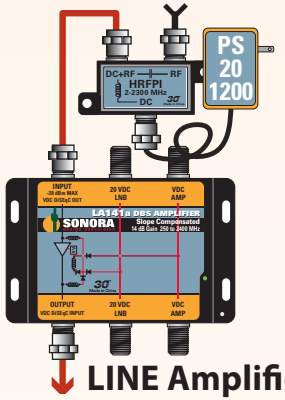
Pre-Amplifier

DC OUT INPUT



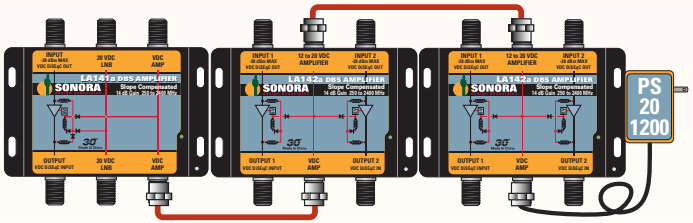
LINE Amplifier

DC OUT INPUT



LINE Amplifier

DC OUT OUTPUT

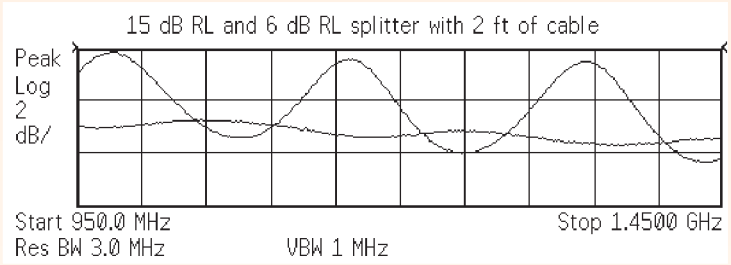


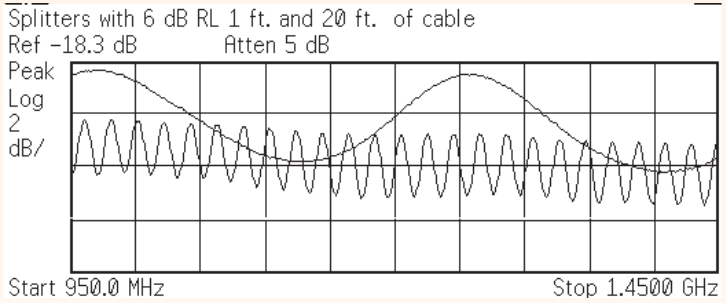
Shared DC (5) Polarity Node Amplifier

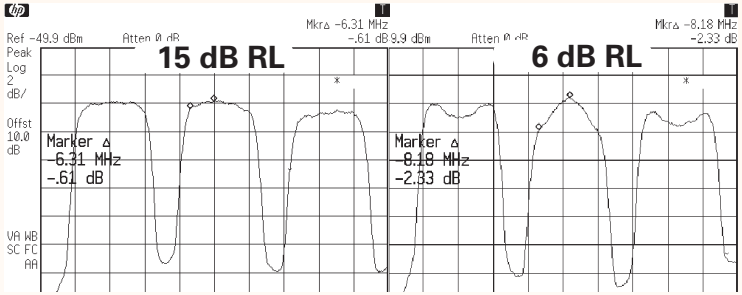
NO DC OUT

Multi-Mode Amplifier Powering

- There is never enough AC outlets.
- Sonora 14 dB gain, 28 dB gain and autogain amplifiers feature multiple powering options.
- Amplifiers will work with transformer power over a range of 12 to 24 volts. Order **LA141a-T** for example to receive a transformer with the amplifier. **LA141a** is shipped with NO power supply
- Model **HRPIR20** is a 20V, 1.2 Amp power inserter used to place DC on the coax and pass the RF signal.
- Looping power ports are also provided so a single transformer can be used to power multiple amplifiers.
- DC on coax 1 of a dual amplifier is always isolated from DC on coax 2.



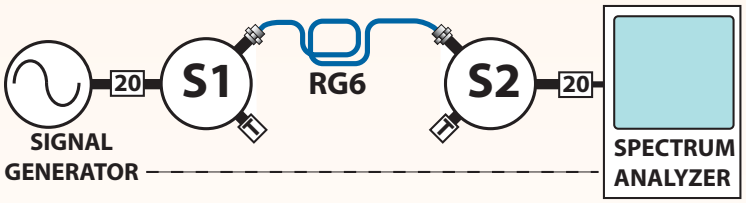




Return Loss & Reflections

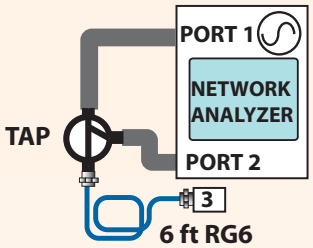
- Devices not equaling 75 ohms reflect part of the signal back to the source. Standing waves are created. The top plot compares the diference between (2) 15 dB return loss devices and (2) 6 dB return loss devices.
- The frequency of the standing waves is proportional to the spacing between devices. The second plot shows (2) 6 dB return loss devices spaced at 1 ft and at 20 feet of coax.
- Transponders passing between the devices are distorted by the standing waves. Note the undistorted 15 dB return Loss signal vs the signal passing through (2) 6 dB RL devices.

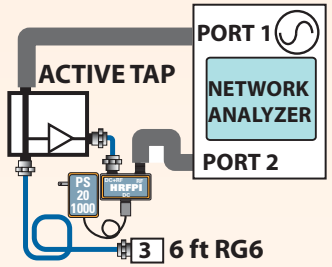
Device 1 Return Loss	Device 2 Return Loss	RIPPLE
15 db	15 dB	0.5 dB
15 dB	12 dB	0.8 dB
15 dB	10 dB	1.0 dB
12 db	12 db	1.1 dB
12 dB	10 dB	1.4 dB
12 dB	8 dB	1.7 dB
10 dB	10 dB	1.7 dB
10 dB	8 dB	2.2 dB
10 dB	6 dB	2.8 dB
6 dB	8 dB	3.5 dB
6 dB	6 db	4.5 db

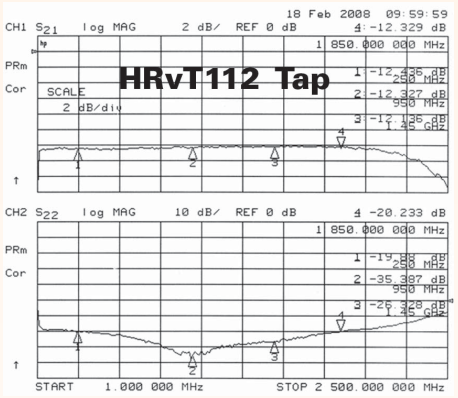


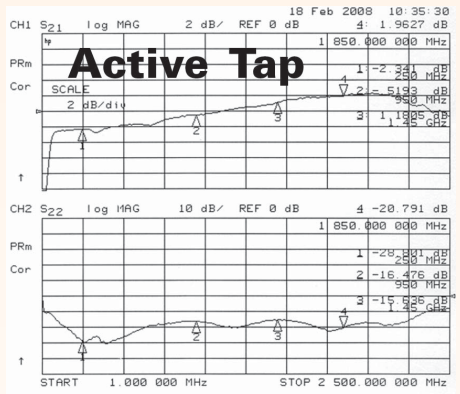
HP Return Loss Calculations

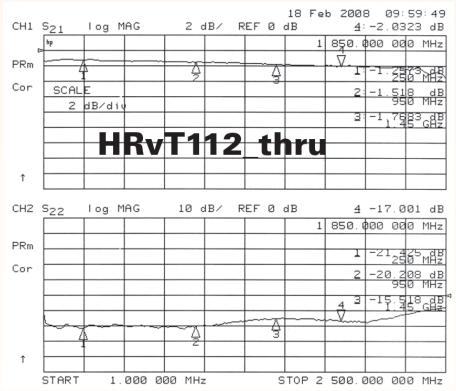
- The reflection amplitude table is created with equations provided by Hewlett Packard. Sonora confirmed the table using known return loss devices.
- CATV systems require 20 dB return loss for devices connected to the trunk.
- Consumer grade products like TV's have from 6 dB to 10 dB return loss.
- Ripple greater than 2 dB peak amplitude can freeze digital signals.
- The test configuration is illustrated. Signal is inserted into the first device using a 20 dB pad to eliminate input reflections. The output of the second device is connected to another 20 dB pad to eliminate output reflections.

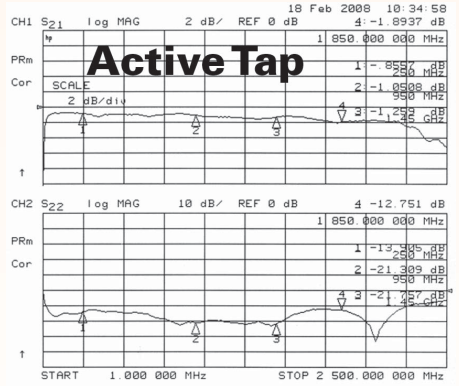












Tap Performance Tests

Frequency Response, Return Loss

Models:

- HRPID1422A polarity locker,
- HRPIR20 20 volt DC power inserter
- HRT106, HRT108, HRT112, HRT116, Directional Couplers
- HRvT106, HRvT109, HRvT112, HRvT116, Directional Couplers
- xxxxx active tap

Equipment:

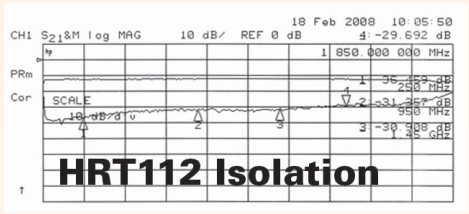
- Network Analyzer (Sonora model HP8753D)
- High return loss power inserter for xxxxx active tap, (Sonora model HRPIR20)

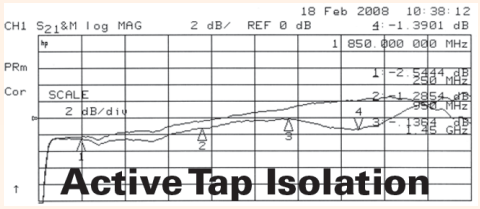
Procedure:

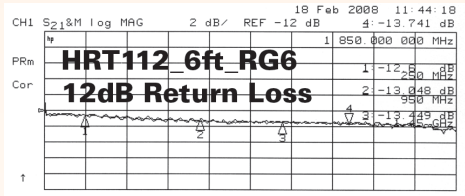
1. Calibrate the network analyzer with 75 ohm matching pads. F Cal Kit 85039B
2. Measure and plot the frequency response, input return loss & output return loss from 250 to 2150 MHz with markers at
   - 250 MHz, 950 MHz, 1450 MHz, 1850 MHz

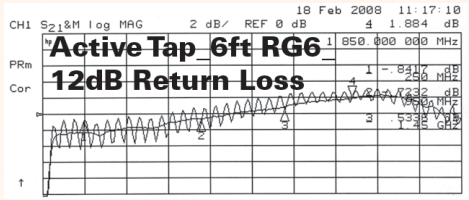
Displayed Results:

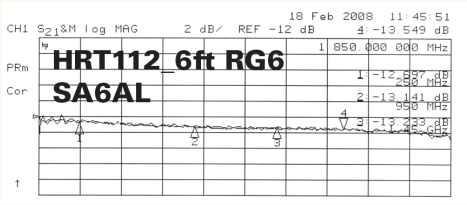
- HRvT112 Directional Couplers: flat response to1850 MHz, 20 dB Tap return loss, 15 dB minimum output return loss
- Active Tap: zero tap loss, 1 dB insertion loss, 13 dB return loss

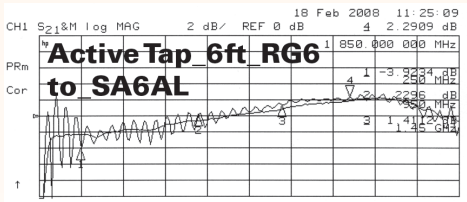












Tap Isolation Response

Procedure:

Measure and plot the OUTPUT to TAP, isolation from 250 to 2150 MHz with markers at 250 MHz, 950 MHz, 1450 MHz & 1850 MHz

Desired Results:

- Tap Output Isolation should be greater than 10 dB to prevent reflections from the next device passing to the tap port.

TAP ISOLATION DEMONSTRATION

Procedure :

1. Connect a 6 foot of RG-6 jumper to the output connector of the tap.
2. Connect an 6 dB HRF DBS pad to the end of the coax (12 dB return loss)
3. Connect Network analyzer **PORT 1** to the tap input connector
4. Connect the Network analyzer **PORT 2** to the tap port connector
5. Plot the S21 response

Desired Results: Directional couplers isolate the tap port from reflected signals returning to the coupler output. The amplitude of the ripple is a function of the return loss the next device in the trunk.

Displayed Results:

- HRvT112 Directional Couplers: **30 dB tap isolation**, no measurable ripple
- Active Tap: **3 dB tap isolation**, 3 to 4 dB ripple