

R-F Skewed Hybrids
Type H1SB and H1SB-R
&
R-F Balanced Hybrids
Type H1R, H2R, H3X and
Type H1RB, H2RB, H3XB

System Manual

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IMPORTANT

We recommend that you become thoroughly familiar with the information in this manual before energizing your hybrid assembly. Failure to do so may result in injury to personnel or damage to the equipment, and may affect the equipment warranty.

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Preface

Scope

This manual describes the functions and features of the R-F Skewed Hybrids Type H1SB & H1SB-R and the R-F Balanced Hybrids Type H1R, H2R, H3X and Type H1RB, H2RB, and H3XB. It is intended primarily for use by engineers and technicians involved in the installation, alignment, operation, and maintenance of the hybrid assemblies.

Equipment Identification

Each hybrid assembly is identified on its nameplate.

Production Changes

When engineering and production changes are made to one of the hybrid assemblies, a revision notation (Sub number) is reflected on the style number, related schematic diagram, and associated parts information.

Warranty

Our standard warranty extends for 24 months after shipment. For all repaired units or advance replacements, the standard warranty is 90 days or the remaining warranty time, whichever is longer. Damage clearly caused by improper application, repair, or handling of the equipment will void the warranty.

Equipment Return & Repair Procedure

To return equipment for repair or replacement:

1. Call your PULSAR representative at **1-800-785-7274** or visit our web site at **www.pulsartech.com**.
2. Request an **RMA number** for proper authorization and credit.
3. Carefully pack the equipment you are returning.

Repair work is done most satisfactorily at the factory. When returning any equipment, pack it in the original shipping containers if possible. Be sure to use anti-static material when packing the equipment. Any damage due to improperly packed items will be charged to the customer, even when under warranty.

Pulsar Technologies, Inc. also makes available interchangeable parts to customers who are equipped to do repair work. When ordering parts, always give the complete PULSAR style number(s).

4. Make sure you include your return address and the RMA number on the package.
5. Ship the package(s) to:

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Chapter 1. R-F Skewed Hybrids

Table 1-1. R-F Skewed Hybrid Styles and Descriptions.

Type	Style Number	Description
H1SB	1609C45G01	50 ohms
H1SB	1609C45G02	75 ohms
H1SB-R	1609C45G03	50 ohms w/50 Ohms Terminating Resistor

1.1 Application

The H1SB and H1SB-R Skewed Hybrid units are used to combine a transmitter and a receiver to a common load, such as line tuning equipment or a line coupling device. The H1SB-R differs from the H1SB in that it has a terminating, non-inductive 50 ohm resistor on the receive port. This eliminates the need for an external resistor on the receive port to produce the 50 dB trans-hybrid loss. Normally, the H1SB hybrid should have an external resistor added across the receive port.

The skewed hybrid's transmit path has less than 1 dB of loss rather than the normal 3.5 dB of loss in a balanced hybrid. This helps overcome the power line noise at the transmit end and establishes a better signal-to-noise ratio. The trade-off is that the receive path (i.e., the line port to the receive port) has a 13 dB loss. This does not change the signal-to-noise ratio at the receive end, but decreases the level of both signal and noise.

1.2 Construction

The type H1SB and H1SB-R are two-transformer hybrids, with one transformer on the transmit side and the other on the receive side. The H1SB-R includes an extra resistor to terminate the receive port. Both hybrids include a 50/75 ohm balance resistor.

1.3 Operation

The schematic diagram of the H1SB is shown in Figure 1-1. The balance network — R1, R2, L1, and C1 — is designed for a line impedance of 50 or 75 ohms resistive. L1 and C1 are factory selected to provide a transmit-to-receive loss (trans-hybrid loss) of 50 dB when the line is terminated with 50 + j0 or 75 + j0, and the receive port is also terminated with 50 or 75 ohms. You can use the measurement of the transhybrid loss to determine how well the line is matched to 50 or 75 ohms.

For example, if the measured loss from transmit port to receive port were 35 dB, the return loss of the line would be 35-12 or 23 dB. (The 12 dB loss is designed into the hybrid). 23dB return loss would correspond to a VSWR of 1.15 or a line impedance of 43 to 57 or 65 to 86.3 ohms. This is given by the equations:

$$\text{RETURN LOSS} = 20 \log \frac{|Z + 50|}{|Z - 50|} \quad (\text{for 50 ohms})$$
$$\text{VSWR} = \frac{1 + \sqrt{\frac{P_R}{P_F}}}{1 - \sqrt{\frac{P_R}{P_F}}}$$

If the need arises, you can connect an external balance network to J1-2 and J1-1 and mount it external to the unit (you can remove L1 and C1, if required).

You may use TP4 to monitor the transmitter input and TP2 to monitor the receiver input.

1.4 Specifications

The technical specifications for the R-F skewed hybrids type H1SB and H1SB-R are provided in Table 1-2.

1.5 Adjustments

The R-F skewed hybrids (type H1SB and H1SB-R) do not require any adjustments.

1.6 Maintenance

The R-F skewed hybrids (type H1SB and H1SB-R) require very little maintenance. At annual inspection intervals, remove any accumulated dust.

Table 1–2. R-F Skewed Hybrid Technical Specifications.

Maximum Power Transmitter Input	100 Watts (Avg.)
Frequency Range	30 kHz -500 kHz
Insertion Loss*	
Transmit Port to Line Port	less than 1 dB
Line to Receive Port	13 dB
Isolation TX to RCVR (Transhybrid Loss)*	50 dB Line
Output Impedance	50 ohms G01, G03 or 75 ohms G02
Input Impedance TX	50 ohms

*With exact impedance matching at all ports.

Table 1–3. R-F Skewed Hybrid (Type H1SB, H1SB-R) Components.

Location	Name	Style Number	Description	Quantity		
				H1SB		H1SB-R
				50 Ω	75 Ω	50 Ω
T1	Transformer	1487B42G01	Matching Transformer	1	1	1
T2	Transformer	1487B44G01	Matching Transformer	1	1	1
R1, R3	Resistor	RL500AJAZZ	50 Ω , 10 W, 5%	1	–	2
R1	Resistor	RL750AJAZZ	75 Ω , 10 W, 5%	–	1	–

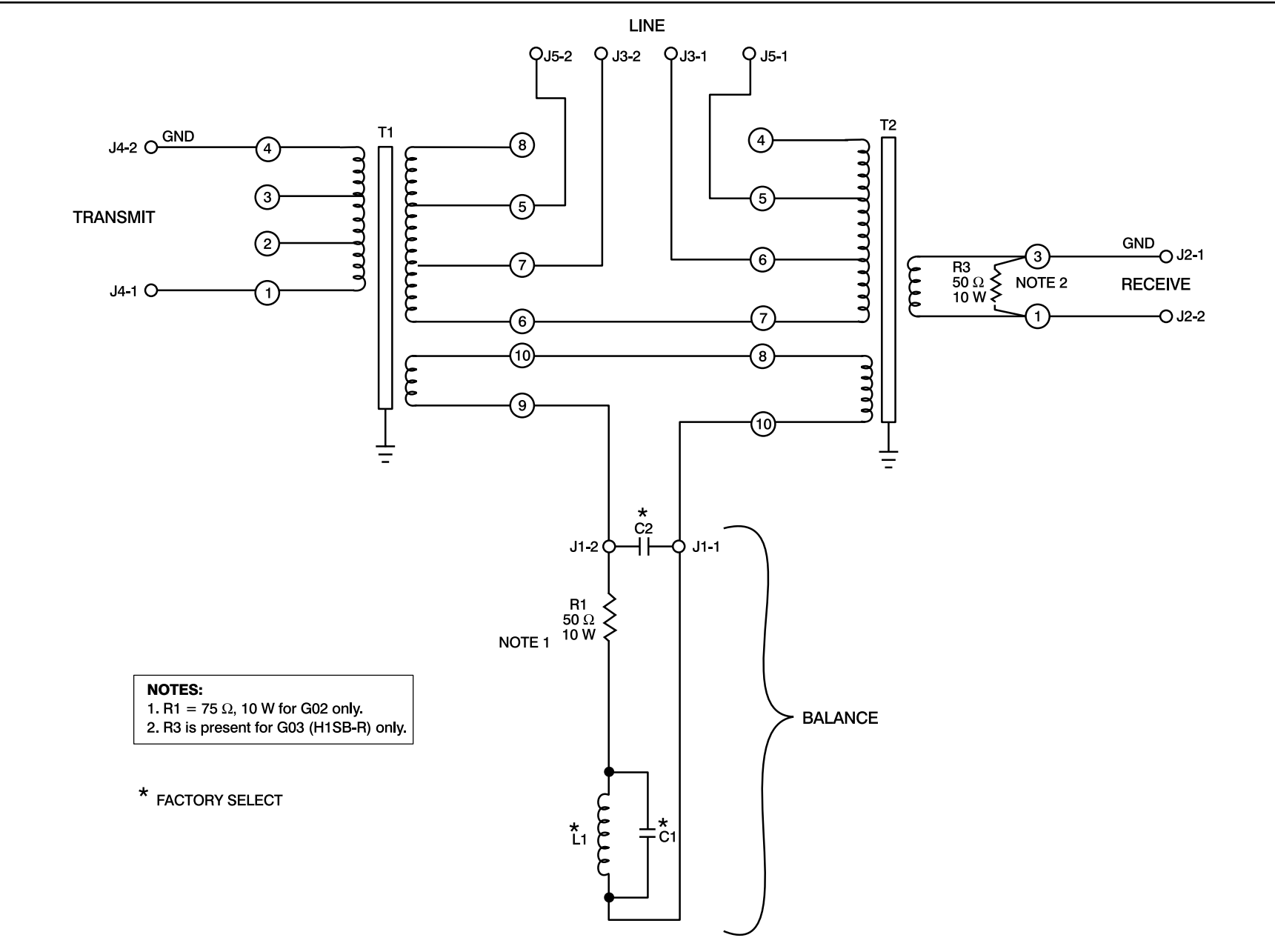


Figure 1-1. H1SB and H1SB-R Internal Schematic (1609C45, Sheet 3 of 3, Sub 5).

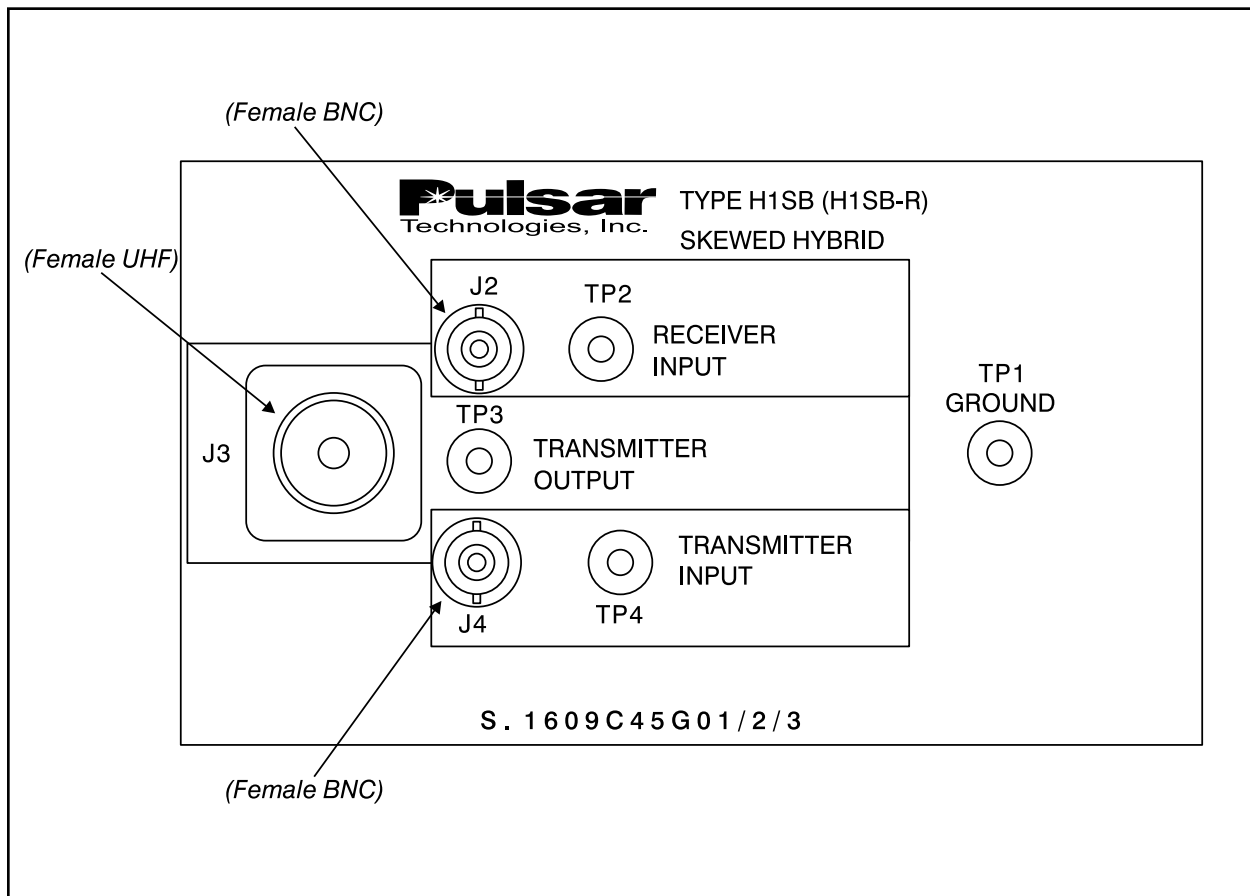


Figure 1-2. H1SB and H1SB-R Connectors and Labeling.

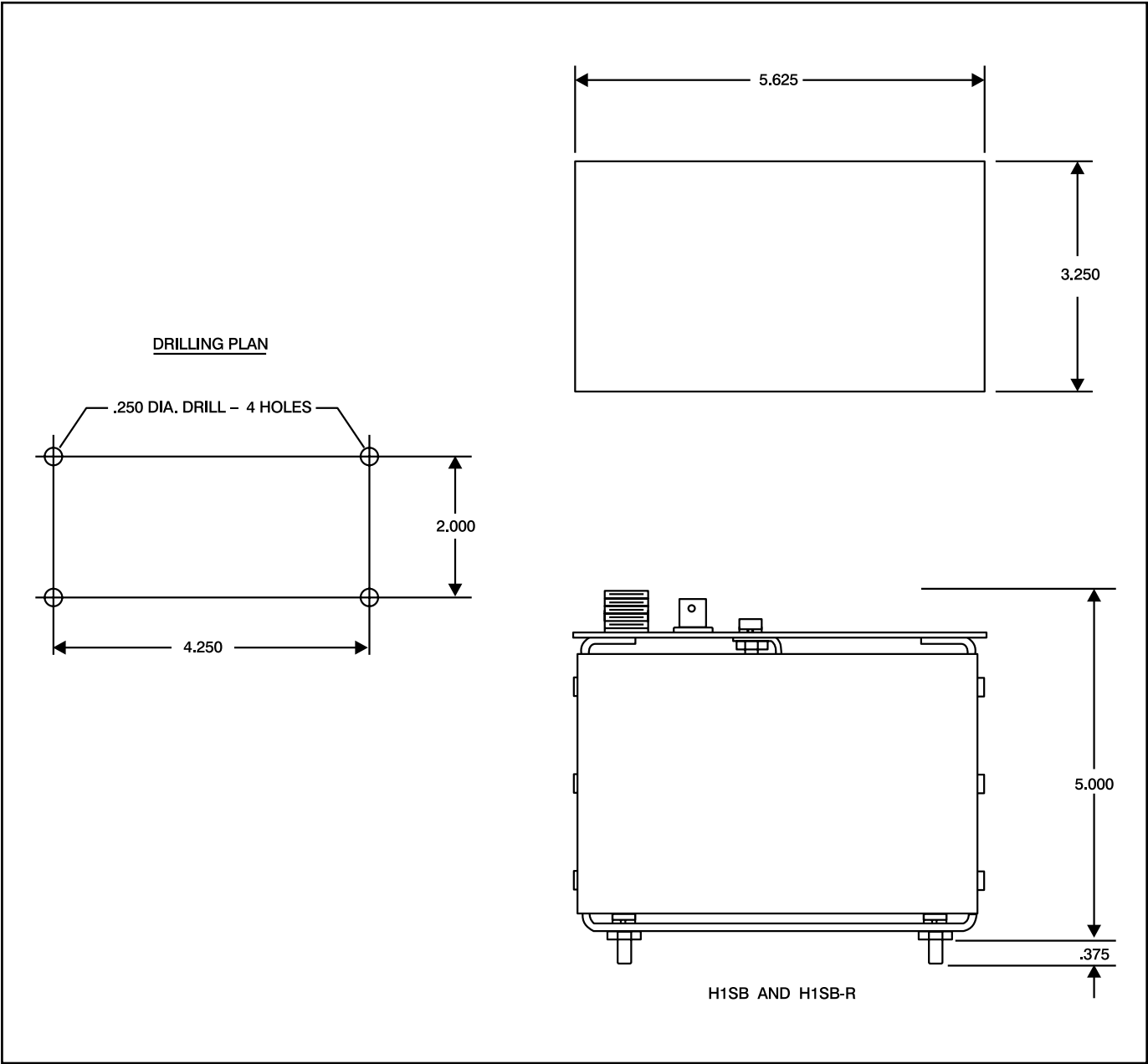


Figure 1-3. H1SB and H1SB-R Outline Drawing (204C184, Sub 1).

Chapter 2. R-F Balanced Hybrids

Table 2-1. R-F Balanced Hybrid Styles and Descriptions.

	Type	Style Number	Description
Resistive Hybrids	H1R	6266D72G01	60 ohms
	H2R	6266D72G03	60 ohms
	H1RB	6266D72G05	50 ohms
	H2RB	6266D72G06	50 ohms
Reactance Hybrids	H3X	6266D71G01	44-75 ohms
	H3XB	6266D71G03	36-63 ohms

2.1 Applications

The type H1R, H1RB, H2R, H2RB, H3X, and H3XB RF hybrids are used to provide isolation between two or more closely spaced carrier transmitters operating effectively in parallel into a common coaxial cable. They are also used between transmitters and receivers to prevent the local transmitter from overloading the receiver input circuit. Hybrids present high signal losses from one input to the other input (return loss), but give low losses from input to output or output to either input (insertion loss). Using these hybrids thus allows closer frequency spacing than normal when paralleling equipment directly.

The H1R, H1RB and H2R, H2RB hybrids have a resistive balance impedance. These are single-unit and double-unit hybrids, respectively. Use these resistive type hybrids when applying several hybrids in cascade; the correct output terminating impedance of 60/50 ohms is provided by the input of the next hybrid in the series. The last hybrid in the series (with output to coaxial cable and line tuner), however, must be the H3X, H3XB unit, which has a reactive balance network (R, L, and c). This lets you tune the hybrid to match the

combined impedance characteristic of the line tuner, coupling capacitor, and power line. If only a single hybrid is required, it must be the reactive type H3X, H3XB unit.

2.2 Construction

2.2.1 H1R, H1RB Construction

The type H1R, H1RB (see Figure 2-1) is the resistive type hybrid, which consists of a wide-band matching transformer and a 30/25 ohm non-inductive balance resistor. The primary winding of the transformer consists of two identical sections to provide an accurate mid-tap. The secondary of the transformer has no taps. A 0.0015 μ F. capacitor is connected across the secondary to compensate for leakage inductance of the transformer over the entire frequency band.

2.2.2 H2R, H2RB Construction

The type H2R, H2RB consists of two units of H1R, H1RB with the same type of construction as described above.

2.2.3 H3X, H3XB Construction

The type H3X, H3XB (see Figure 2-2) is a reactance type hybrid and has provision for tuning and impedance matching. This hybrid consists of a matching transformer and a balance network containing resistance, inductance, and capacitance. The primary winding of the H3X, H3XB transformer is similar to the winding of the H1R, H1RB transformer, but the secondary has 10 taps to provide an impedance range of 36–63 ohms.

The H3X, H3XB tuning network consists of several capacitors, which you can connect in parallel for any combination (see Table 2-2), and a tuning coil, which has five taps and an adjustable core to provide the inductance range of 20 to 1000 microhenries. The combination of the capacitors and the inductor taps provide tuning over the frequency range of 30 to 500 kHz, as shown in Table 2-3.

The balance resistor has three taps (A, B, C) to provide a fine adjustment for the best balance condition (return loss) at the hybrid input at its tuned frequency.

Outline dimensions for the balanced hybrids are shown in Figure 2-3. A 19-inch mounting panel two rack units high (nominally 3 1/2 inches) that will accommodate a total of three hybrid units is available. It will house, for example, two H2R, H2RB units and one H3X, H3XB unit. This is adequate for most applications.

2.3 Operation

Hybrids provide a means of coupling two or more carrier transmitters or transmitters and receivers to a common coaxial cable output circuit with negligible interaction between the units. With reference to Figure 2-1, if you connect a 60/50 ohm load to the output (at P1), a reflected load of 30/25 ohms will appear across each half of the mid-tapped winding. Thus a carrier transmitter connected to Input 1 will see a load impedance of 60/50 ohms: 30/25 ohms reflected impedance across

Table 2-2. Capacitance Values – H3X, H3XB Hybrid.

Capacitance in μF	Connect Terminals From/To
.0068	1 to 2
.0100	2 to 3
.0150	4 to 5
.0168	1 to 2 and 2 to 3
.0200	5 to 6
.0218	1 to 2 and 4 to 5
.0250	2 to 3 and 4 to 5
.0268	1 to 2 and 5 to 6
.0300	2 to 3 and 5 to 6
.0318	1 to 2, 2 to 3, and 4 to 5
.0350	4 to 5, 5 to 6
.0368	1 to 2, 2 to 3, and 5 to 6

the upper half of the transformer T1 mid-tapped winding plus the 30/25 ohms of the R1 balance resistor. The full transmitter output voltage (to ground) will be present at J3, with one-half of this voltage appearing at the mid-tap of transformer T1. Because of the auto-transformer action of T1 primary winding, the voltage appearing at J4 (the opposite input) will be essentially zero (down 30 dB minimum from the transmitter output level). With a resistive load, this balance will exist over the entire carrier band of 30 to 500 kHz.

For the hybrid which connects to the coaxial cable, line tuner, and coupling capacitor, a simple balance resistor is inadequate to provide a satis-

Table 2-3. Tuning Ranges of H3XB Hybrid.

Frequency Range	L-Tap	C-Taps	μF
30 – 40	1.0	1-2-3, 4-5-6	0.518
40.1 – 5	.4	1-2-3, 4-5-6	0.518
55.1 – 8	.25	1-2-3, 4-5-6	0.518
85.1 – 120	.1	1-2-3, 4-5-6	0.518
120.1 – 150	.1	1-2, 4-5-6	0.418
150.1 – 200	.035	1-2, 4-5-6	0.418
200.1 – 300	.035	1-2-3, 5-6	0.418
300.1 – 400	.035	5-6	0.518
400.1 – 535	.035	4-5	0.518

factory return loss over a reasonable band of frequencies. For this unit, the balance network includes resistance, inductance, and capacitance to get a good balance over a band of frequencies.

2.4 Specifications

The technical specifications for the R-F balanced hybrids type H1R, H2R, H1RB, and H2RB are provided in Table 2-4.

Table 2-4. R-F Balanced Hybrid Technical Specifications.

Characteristic	H1R, H2R H1RB, H2RB	H3X, H3XB
Frequency Range	30-500 kHz	30-500 kHz
Max. Power, each input	15 watts	15 watts
Output Impedance	60/50 ohms	44-75 ohms
Range-Taps	none	3-4 ohm intervals
Insertion Loss — with exact impedance matching:		
Input to Output	3.5 dB max.	3.5 dB max.
Output to Input	3.5 dB max.	3.5 dB max.
Transhybrid Loss — each input to other input with exact impedance matching:		
For all frequencies	30 dB min.	—
For any one frequency	30 dB min.	40 dB min.
Bandwidth for 30 dB return loss: [†]		
30-50 kHz	—	4%
50.1-300kHz	—	6%
300.1-500 kHz	—	8%
[†] Receivers are not subject to these limitations.		

2.5 Adjustments

2.5.1 H1R, H2R, H1RB, H2RB Adjustments

These types of hybrid do not require any adjustments.

2.5.2 H3X, H3XB Adjustments

Before adjusting these hybrids, you must first adjust all other related components of the carrier installation according to their respective instructions. These include:

1. Line taps on the carrier channel where the hybrids are used.
2. Carrier transmitters. You should separately adjust these for rated output into a 60/50 ohm non-inductive load resistor, making sure that any output filter or associated series L/C unit is tuned to resonance.
3. Line tuning equipment. Because an associated transmitter is generally used as the signal source for adjusting a line tuner, you should bypass the R-F hybrid(s) for this step. You can do this by disconnecting the transmitter output from its associated hybrid and connecting it directly to the coaxial cable to the line tuner.

NOTE

If only one transmitter is involved with the hybrid, you may use it to adjust the line tuner and the hybrid. For two closely spaced transmitters, use either one. If three or more transmitters are involved, use the one whose frequency is nearest the center of the group of transmitter frequencies.

After completing the above adjustments, you can return the transmitter output connections to normal. Now you can adjust the H3X hybrid, using the same transmitter you used to adjust the line tuner. Just complete the following 10 steps:

1. Connect an electric ac voltmeter across the other input of the H3X, H3XB hybrid to which the selected transmitter (per the note

above) is connected. You can make this connection from the small red pin jack to ground. To reject noise and other carrier signals which may be present, it is preferable to use a frequency selective voltmeter for this purpose. Turn it to the frequency of the associated carrier transmitter.

2. Set the H3X, H3XB hybrid taps as follows:
 - a) Set the ohms tap to 60/50, unless you know the input impedance of the coaxial cable to be some other value. In that case, set it to the known value.
 - b) Set the balance tap (BAL.) to tap B.
 - c) Initially set the capacitor links and the inductance tap (IND., MH) in accordance with Table 2-3 for the frequency of the transmitter being used. Take care that the spade connectors on the tap leads do not touch the capacitor links.
 - d) Turn out (counter-clockwise) the threaded shaft of the tuning core until about one-half inch of the threaded portion is visible.
3. Turn on the carrier transmitter and note the reading of the voltmeter. If you are using a frequency selective voltmeter, turn it for maximum reading.
4. Now turn out the threaded shaft of the tuning core until you get a minimum value on the voltmeter connected to the second hybrid input. If the output load is resistive, you will get a definite minimum within the range of the tuning inductance. If the voltmeter reading is only slowly decreasing, and you reach no minimum at the extreme position of the core screw, use the next lower capacitance value listed in Table 2-2. Conversely, if the voltmeter reading increases as the core screw is turned out, use the next higher value of capacitance.
5. After you obtain the best possible balance in Step 4, check other impedance taps above and below 60/50 ohms to see if you can obtain a still lower voltmeter reading (i.e., a better return loss). If you select a different tap, readjust the tuning core for minimum voltage.

6. Change the balance taps (A–B–C) and leave it on the tap giving the lowest voltmeter reading.
7. As a last step, readjust the tuning core to be sure it is set for the minimum voltmeter reading. Lock the core screw in this position using the knurled locking ring.
8. Now you have completed the matching and tuning, and the voltmeter reading should be about 40 dB less than the transmitter voltage (at the other transmitter jack). If, however, the voltage reading is higher than the expected value, repeat steps 4, 5, 6, and 7 for a minimum voltage. The actual value will depend on how closely the hybrid terminating impedance matches the Z tap in use, and whether the voltmeter is of the frequency-selective type. Also, the reading may be 5–6 dB higher with the impedance load of a TCF receiver.
9. In some cases, you may not be able to decrease the voltmeter reading to the desired value by readjusting the hybrid taps. This situation may indicate that the line tuning equipment is not adjusted properly for that specific frequency; and therefore making a slight readjustment to the inductance of the line tuning equipment would bring the voltage to the desired minimum value.
10. After completing the adjustment of the H3X, H3XB hybrid, turn on all the transmitters and note the signal level that each produces at the opposite input of the H3X, H3XB hybrid. (This will require a tuned voltmeter set for a narrow bandwidth.) This procedure will show that the complete system is operating properly.

Table 2–5. Resistive Hybrid (Type H1R, H1RB, H2R, H2RB) Components.

Location	Name	Style Number	Description	Quantity			
				H1R	H2R	H1RB	H2RB
R1	Resistor	880A353H02	30 Ω , 25 W, non-inductive	1	2	–	–
R1	Resistor	880A353H03	25 Ω , 25 W, non-inductive	–	–	1	2
C1	Capacitor	726A680H05	.0015 μ F, 10%, 2 KV	1	2	–	–
T1	Transformer	204C175G01	Matching Transformer	1	2	–	–
T1	Transformer	1502B44H01&02	Matching Transformer	–	–	1	2

Table 2–6. Reactance Hybrid (Type H3X, H3XB) Components.

Location	Name	Style Number	Description	Quantity	
				H3X	H3XB
R1	Resistor	880A353H01	28 Ω , 25 W, non-inductive	1	–
R1	Resistor	880A353H04	23 Ω , 25 W, non-inductive	–	1
R2, R3	Resistor	848A645H15	1 Ω , 1 W, 5%	2	2
R4	Resistor	877A136H02	70 Ω , 5 W, 5%	1	1
C1	Capacitor	187A705H40	680 pF, 1,200 V	1	1
C2, C4, C5	Capacitor	187A705H38	10,000 pF, 1,200 V	3	3
C3	Capacitor	187A705H39	15,000 pF, 1,200 V	1	1
–	Coil Assembly	204C171G01	20–1,000 Microhenries	1	1
T1	Transformer	204C175G02	Matching Transformer with ten taps on secondary	1	–
T1	Transformer	1611C41G01	Matching Transformer with ten taps on secondary	–	1

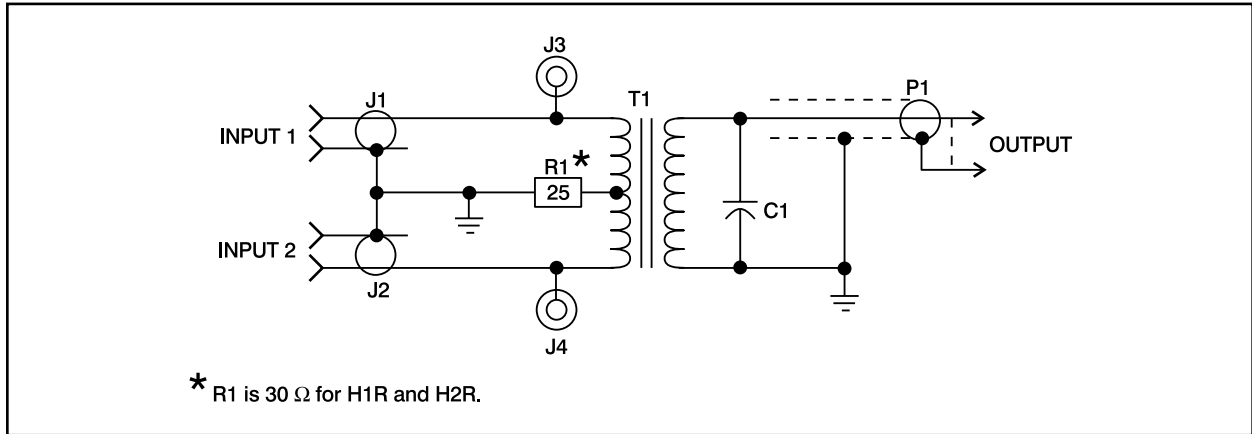


Figure 2-1. Type H1R H1RB, H2R, and H2RB Internal Schematic (878A481, Sub 3).

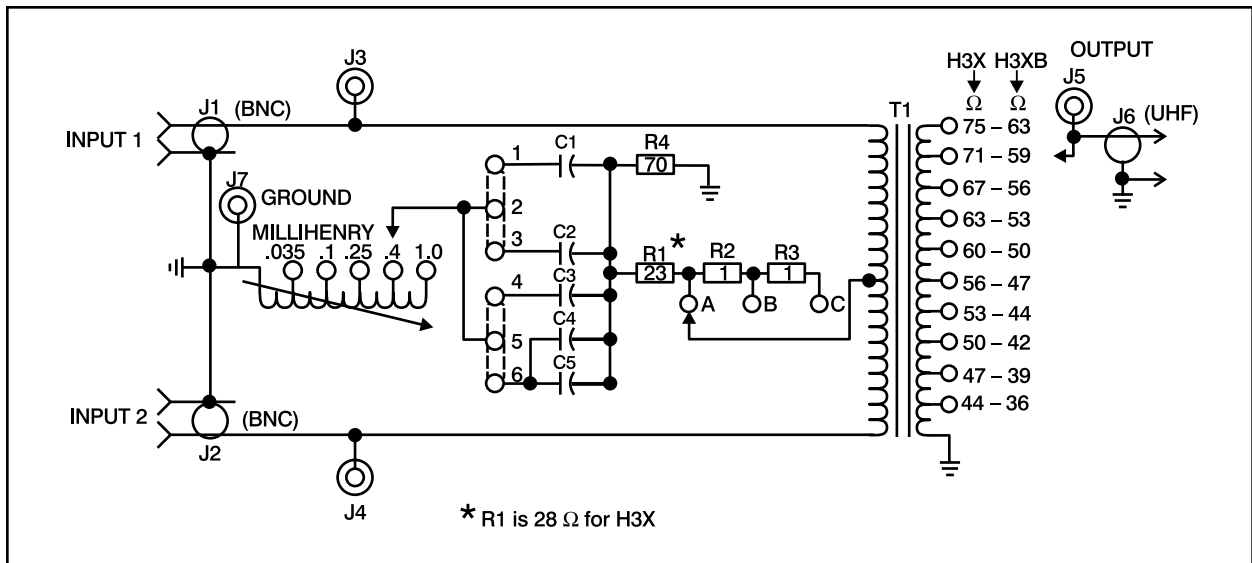


Figure 2-2. Type H3X and H3XB Internal Schematic (878A482, Sub 5).

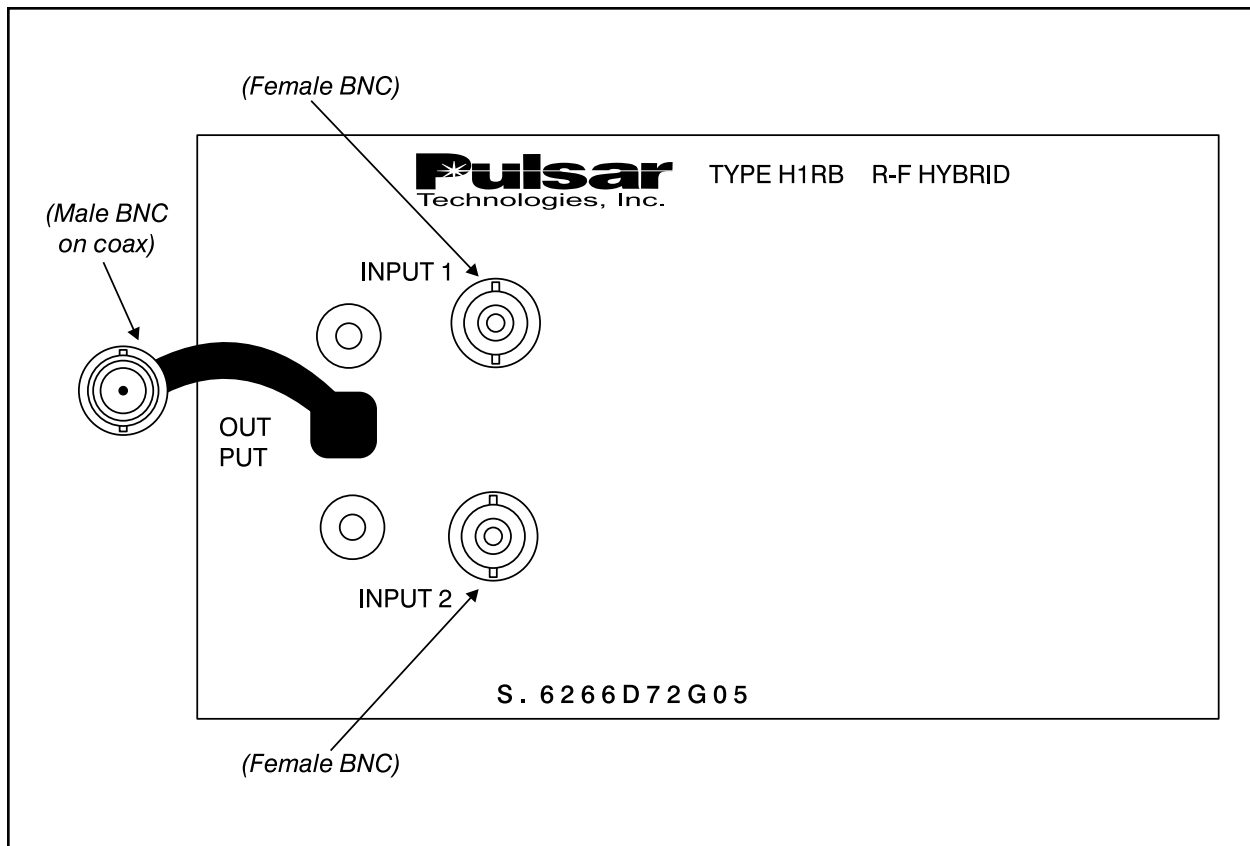


Figure 2-3. Type H1R and H1RB Connectors and Labeling.

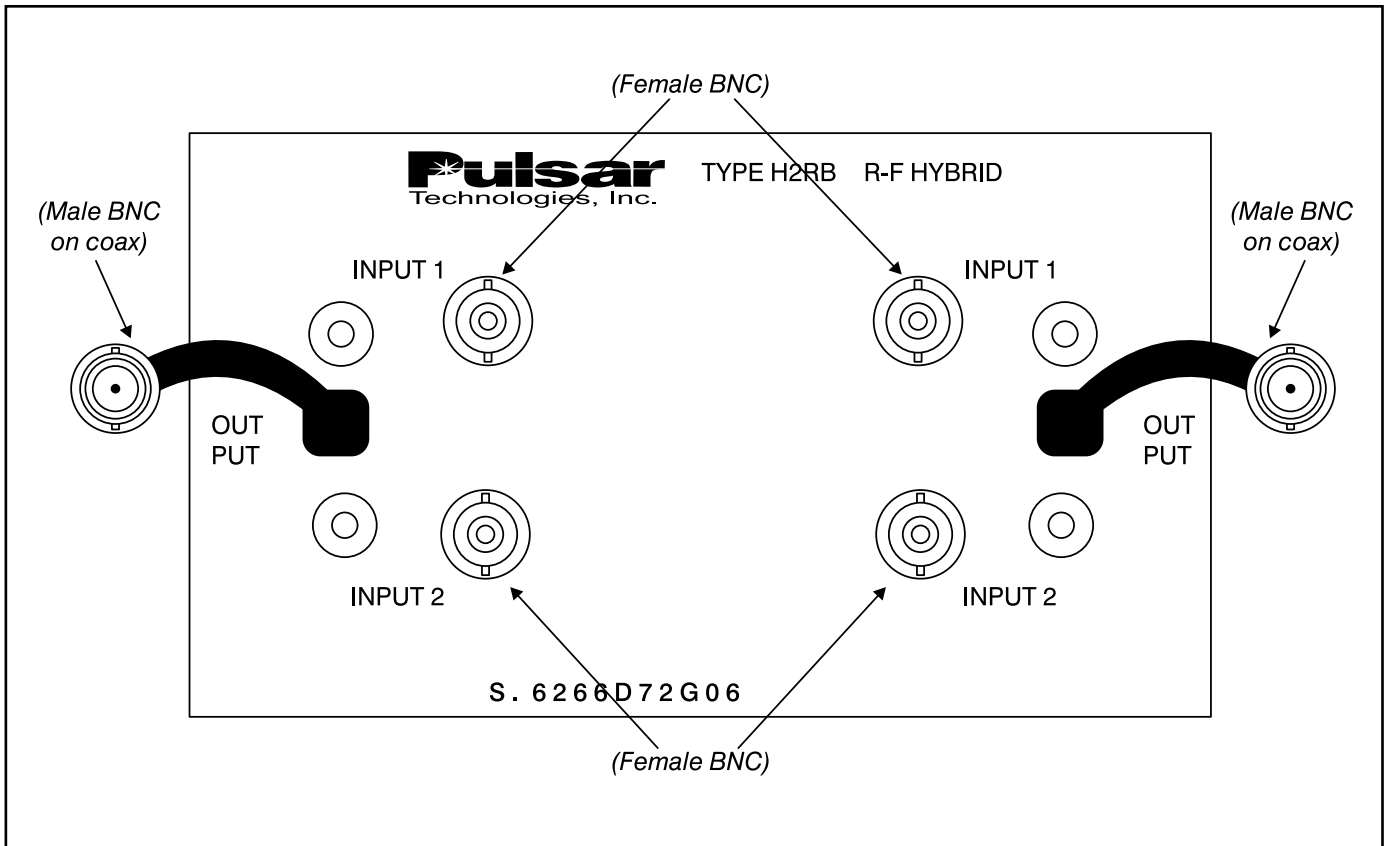


Figure 2-4. Type H2R and H2RB Connectors and Labeling.

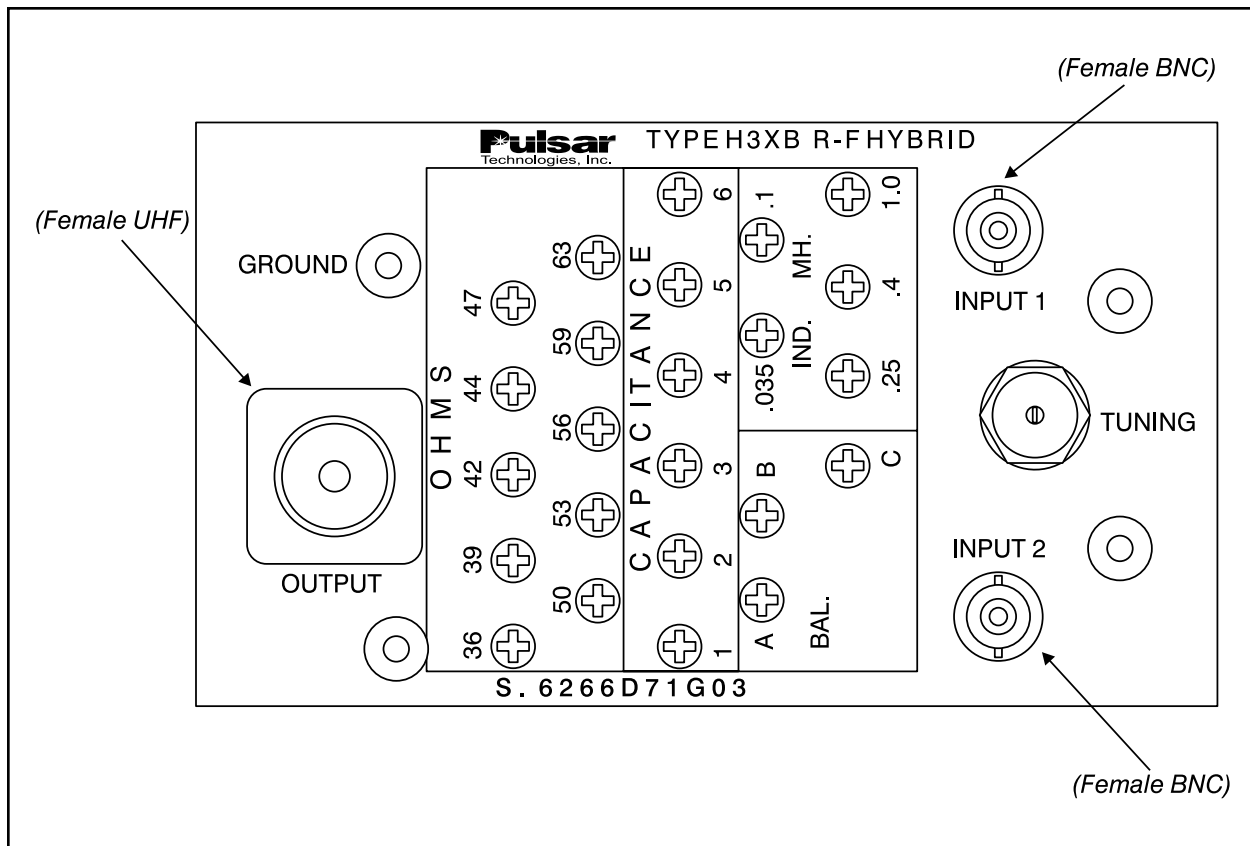


Figure 2-5. Type H3X and H3XB Connectors and Labeling.

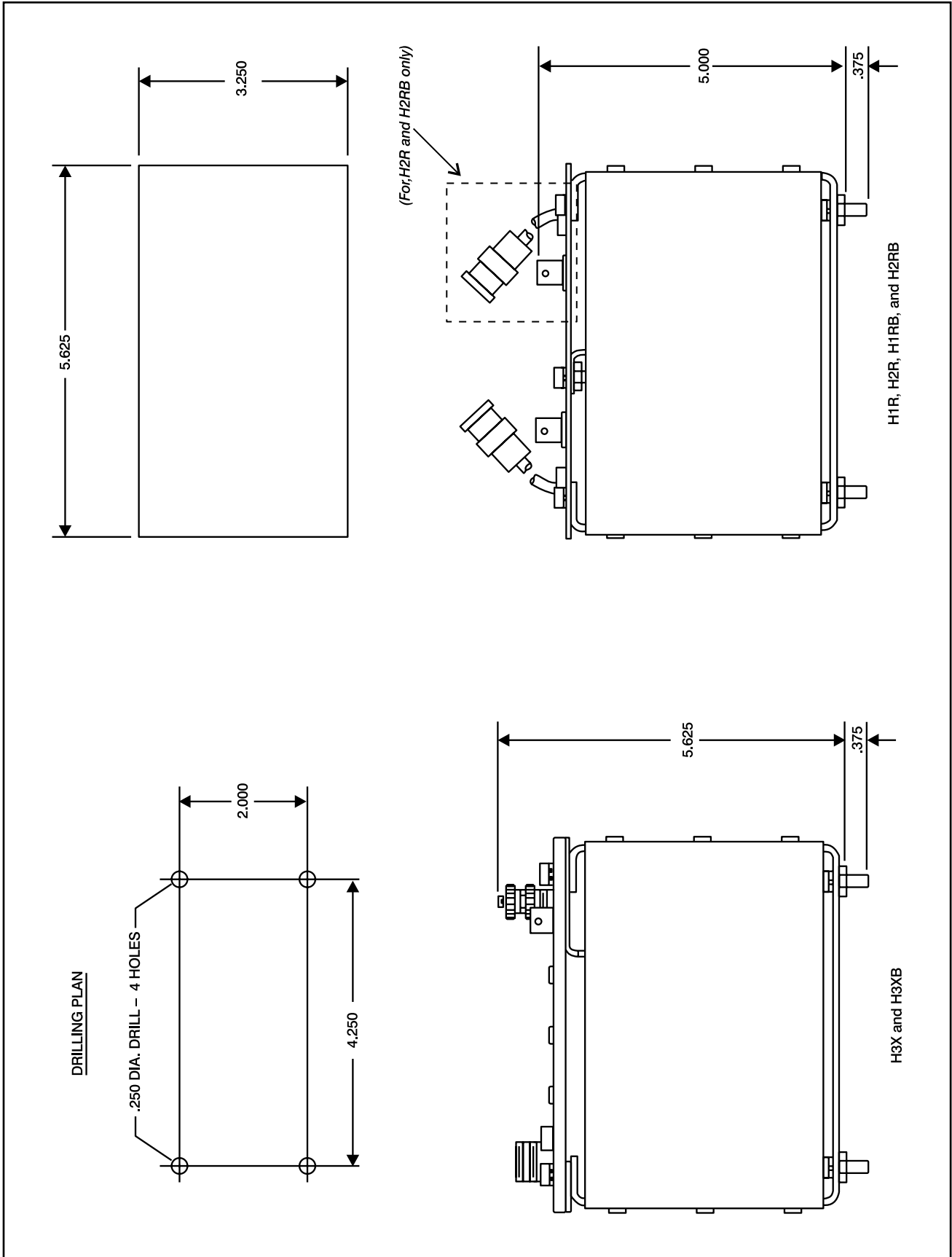


Figure 2-6. H1R, H1RB, H2R, H2RB, H3X, and H3XB Outline Drawing (204C184, Sub 1).

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