INSTRUCTION MANUAL
FOR
48660 SINGLE CHANNEL CDMA PCS BI-DIRECTIONAL AMPLIFIER

Intelli BDA®

CELWAVE®
DIVISION OF RADIO FREQUENCY SYSTEMS, INC.
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Part Number: J24004
Drawing Control: JD16049

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READ THIS MANUAL; WARRANTY DOES NOT COVER IMPROPER HANDLING!

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PRODUCT OVERVIEW and GENERAL INFORMATION

The 48660 Bi-directional Amplifier is a single channel CDMA PCS repeater. It is designed to amplify just one CDMA channel while rejecting all others. The 48660 is tunable over the entire PCS band and provides approximately 65 dB of gain to the selected channel. The unit is designed to enhance PCS coverage in buildings, basements, parking garages and other RF shielded environments. The unit is wall mountable and requires no periodic maintenance.

PERFORMANCE

This unit has a RF section that provides 65 dB of gain, down conversion and IF filtering. The IF filters use SAW technology for optimal selectivity. After upconversion, the output stage filtering attenuates LO leakage while amplifying the selected channel to the set output power level. The standard product offers channel tuning locally by means of dipswitch or RS-232 connection. The control settings are for frequency selection and gain control to limit power. Automatic power control assumes a wide input power dynamic range and intermodulation distortion control.

BLOCK DIAGRAM

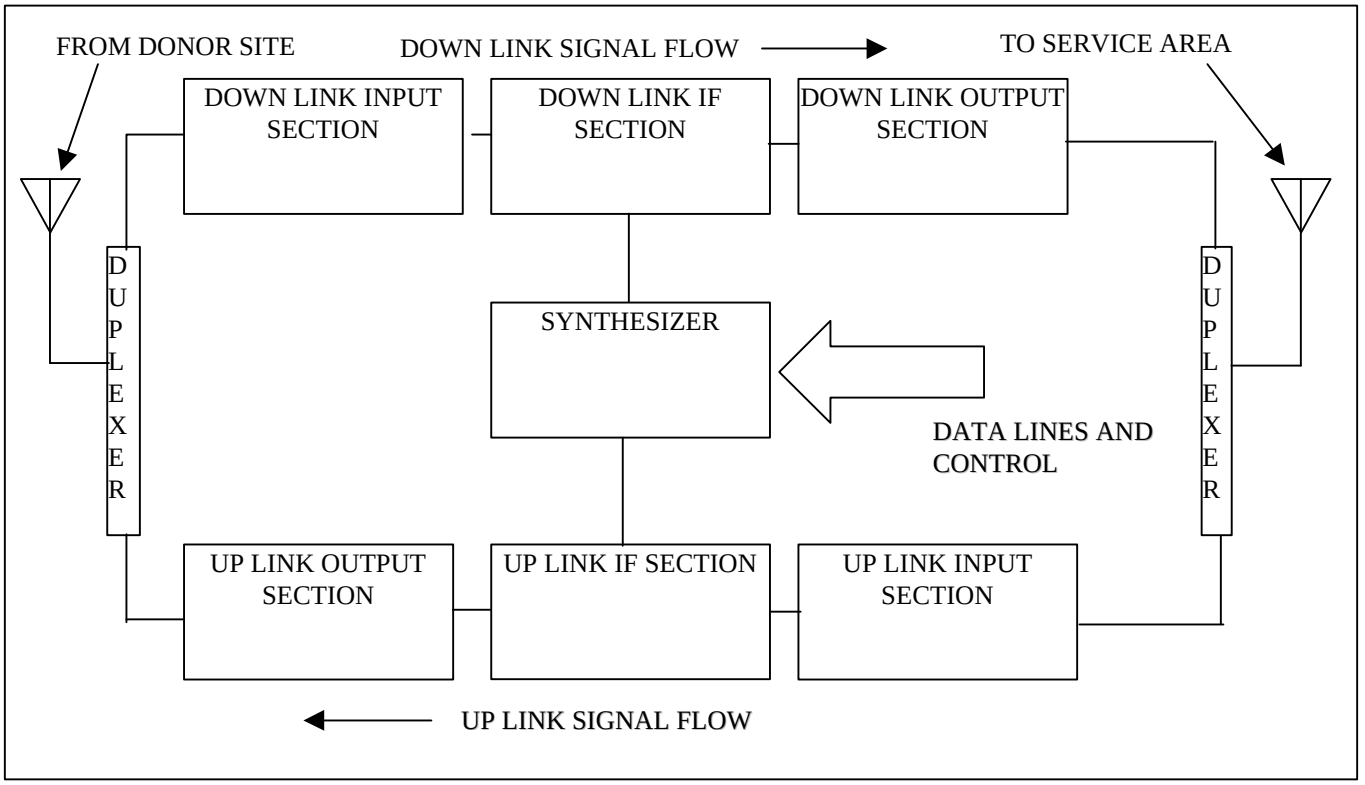


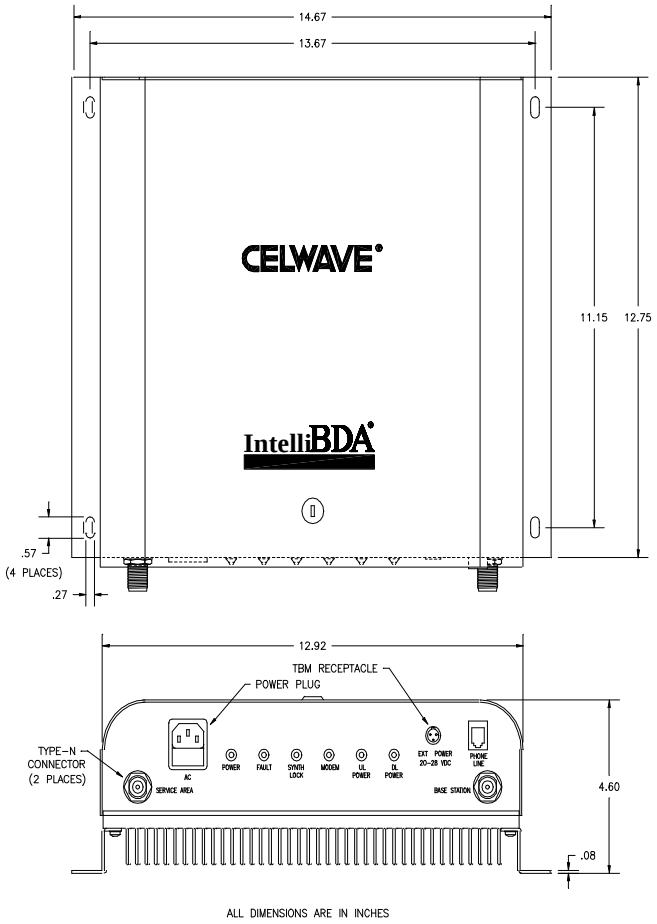
Figure X.1 System Block Diagram

FCC COMPLIANCE

Part Number: J24004
Drawing Control: JD16049

FCC Compliance No: (Application in process.)

OUTLINE DRAWING



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GENERAL SPECIFICATIONS

Specifications may change without notice. All specifications stated as typical unless otherwise noted.

	Down Link (Base to Mobile)	Up Link (Mobile to Base)
Frequency	1930 to 1990 MHz	1850 to 1910 MHz
Typical Pass Band at 3 dB down		
Typical Pass Band at 30 dB down (+22 dB Gain)		
Gain at Min Attenuation -Typ.	65 dB	65 dB
Gain Range, Manual Attenuator	15 dB	15 dB
Pass Band Ripple - Typ.		
Noise Figure - Typ.	6.5 dB	6.5 dB
Output Power Set Point CDMA	+23 dBm	+23 dBm
Power Control Range	+20 dB	+20 dB
3rd Order Intercept Point, IP3	+44 dBm	+44 dBm
Recommended Input Power Maximum, Composite	-35 to -80 dBm	-35 to -80 dBm
Maximum Input Power No Damage	0 dBm	0 dBm
Impedance - Nom	50 Ohms	
VSWR, Input, Both Ports	2.0:1	
Propagation Delay	< 5.0 microsecond	
Power	120 VAC @ 750 mA	
Operating Temperature	-30 to +50^{o} C	
Connectors, RF	N Female	
Diagnostics Interface	RS-232	
Programming	DIP Switches & RS-232	
Size (WxHxD), in. (mm)	14.7 x 12.8 x 4.6 (374 x 325 x 117)	
Weight	19 lbs	

OVERALL THEORY OF OPERATION

The 48660 is a single channel CDMA PCS Bi Directional Amplifier. It is comprised of two main components; Up Link and Down Link. With each component made up of 3 sections, Input Section, IF Section, and Output Section. Refer to Figure X.1. Since the Up Link and Down Link components are virtually identical, only the theory of operation for the Down Link will be presented.

DOWN LINK

Signals originating from the PCS base station are received at the antenna and fed to the input of the 48660. They are then filtered through the first duplexer to attenuate any non-PCS signals which may be received at the antenna. The signal(s) is then fed to the input stage for amplification and additional filtering. If the signal as detected in the output stage is too large, it will receive attenuation in the input section as well. At this point the signal is then fed into the IF section for down conversion, filtering through the SAW devices, additional amplification, and finally up conversion back to it's original frequency. By using the same Local Oscillator for the down and up conversions, frequency accuracy is maintained. The newly up converted signal is then an exact replica of the original signal only very highly filtered to get rid of any other signals near it. This signal is fed into the output section where additional amplification takes place as well as Local Oscillator filtering. Special care has been taken in the design of the 48660 Intelli BDA to maintain good spectral purity of the CDMA signal. It meets or exceeds the spectral regrowth criteria of ANSI J-STD-008 at it's rated output power.

OUTPUT POWER

After all of the amplification and filtering is completed, a sample of the signal is measured and the output power is predicted. This information is fed back to the Digital section and a Power Control voltage is generated and fed to the input section attenuators to reduce the power if needed. This comprises the power control loop. Its response is slow compared to the CDMA closed loop power control, so it will not interfere with the system.

The output power of both RF links is set at the factory to be nominally +23 dBm. As the input signal increases to a level which, when added to the gain produces an output power larger than the set point, the power control loop takes over to reduce the gain accordingly. This insures that under all input signal conditions below the maximum input signal level (-35 dBm), that the integrity of the CDMA spectrum be maintained.

CHANNEL AND ATTENUATION PROGRAMMING

Programming of the 48660 is accomplished either by DIP Switch Programming of the unit, or remotely via a computer (See Remote Programming Manual TBD). This section addresses the DIP Switch Programming of the Channel and Attenuator Settings.

The DIP Switches (S1) are on the Digital Board located just inside the shroud. They can be accessed by opening the shroud and with a pointed instrument such as a pencil or pen, can be set to certain values to set the frequency (Channel Number) and the Attenuation Settings for the Down Link and Up Link, see Figure XX. Care should be taken when closing the 48660 Intelli BDA shroud to disengage the latching mechanism located at the back of the shroud. Forcing the shroud closed will damage the shroud.

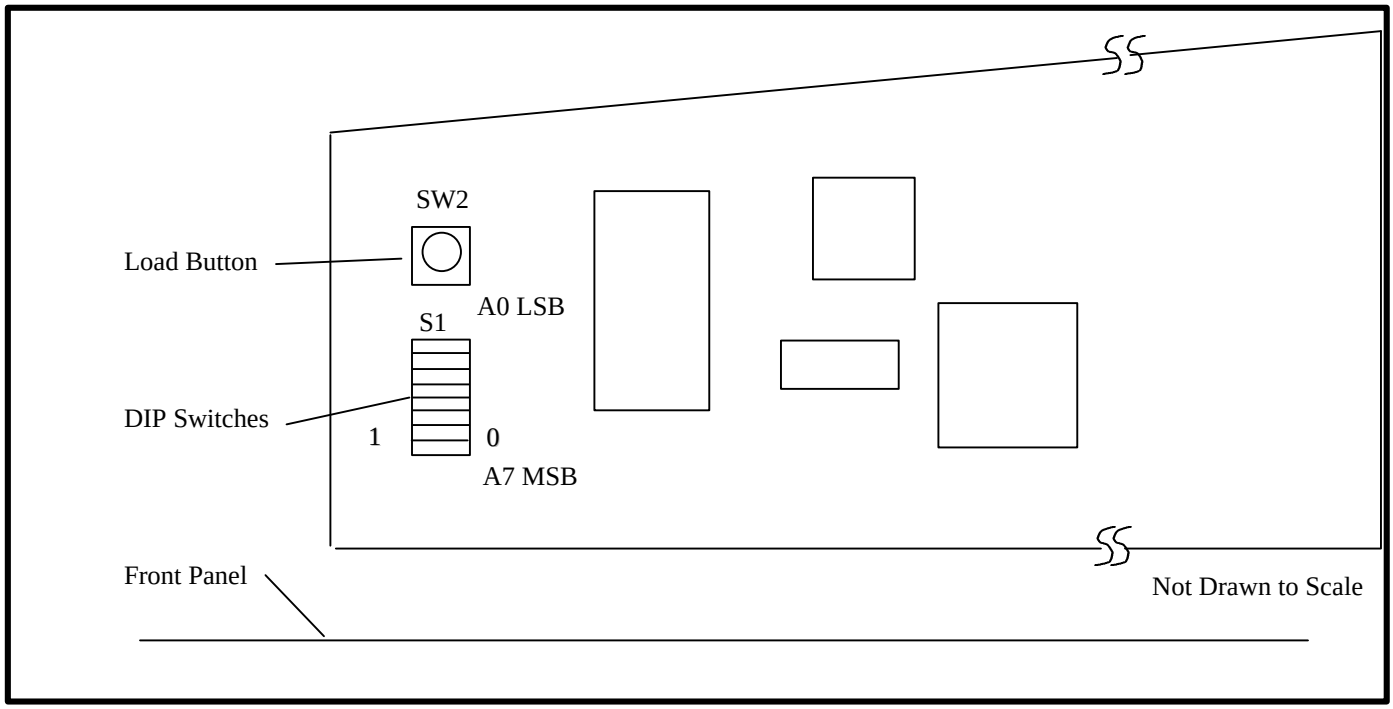

Figure X.X Location of DIP Switch

Upper MSBs		Programming Function
A7	A6	
0	0	Channel Number
0	1	Down Link Attenuation
1	0	Up Link Attenuation
1	1	Reserved for future use

DEC NUM	A5	A4	A3	A2	A1	A0	CH #	FREQ DL (MHZ)	FREQ UL (MHZ)	BLOCK	DL ATTN (dB) TYP	UL ATTN (dB) TYP
0	0	0	0	0	0	0	25	1931.25	1851.25		19.1	19.1
1	0	0	0	0	0	1	50	1932.50	1852.50		19.1	19.1
2	0	0	0	0	1	0	75	1933.75	1853.75		19.1	19.1
3	0	0	0	0	1	1	100	1935.00	1855.00		19.1	19.1
4	0	0	0	1	0	0	125	1936.25	1856.25	**A**	19.1	19.1
5	0	0	0	1	0	1	150	1937.50	1857.50		19.1	19.1
6	0	0	0	1	1	0	175	1938.75	1858.75		19.1	19.1
7	0	0	0	1	1	1	200	1940.00	1860.00		19	19
8	0	0	1	0	0	0	225	1941.25	1861.25		18.9	18.9
9	0	0	1	0	0	1	250	1942.50	1862.50		18.9	18.9
10	0	0	1	0	1	0	275	1943.75	1863.75		18.9	18.9
11	0	0	1	0	1	1	325	1946.25	1866.25		18.8	18.8
12	0	0	1	1	0	0	350	1947.50	1867.50	**D**	18.8	18.8
13	0	0	1	1	0	1	375	1948.75	1868.75		18.7	18.7
14	0	0	1	1	1	0	425	1951.25	1871.25		18.6	18.6
15	0	0	1	1	1	1	450	1952.50	1872.50		18.6	18.6
16	0	1	0	0	0	0	475	1953.75	1873.75		18.5	18.5
17	0	1	0	0	0	1	500	1955.00	1875.00		18.5	18.5
18	0	1	0	0	1	0	525	1956.25	1876.25		18.4	18.4
19	0	1	0	0	1	1	550	1957.50	1877.50	**B**	18.3	18.3
20	0	1	0	1	0	0	575	1958.75	1878.75		18.2	18.2
21	0	1	0	1	0	1	600	1960.00	1880.00		18	18
22	0	1	0	1	1	0	625	1961.25	1881.25		17.9	17.9
23	0	1	0	1	1	1	650	1962.50	1882.50		17.7	17.7
24	0	1	1	0	0	0	675	1963.75	1883.75		17.4	17.4
25	0	1	1	0	0	1	725	1966.25	1886.25		17.1	17.1
26	0	1	1	0	1	0	750	1967.50	1887.50	**E**	16.6	16.6
27	0	1	1	0	1	1	775	1968.75	1888.75		16.1	16.1
28	0	1	1	1	0	0	825	1971.25	1891.25		15.5	15.5
29	0	1	1	1	0	1	850	1972.50	1892.50	**F**	14.8	14.8
30	0	1	1	1	1	0	875	1973.75	1893.75		14	14
31	0	1	1	1	1	1	925	1976.25	1896.25		13.31	13.3
32	1	0	0	0	0	0	950	1977.50	1897.50		12.5	12.5
33	1	0	0	0	0	1	975	1978.75	1898.75		11.7	11.7
34	1	0	0	0	1	0	1000	1980.00	1900.00		10.9	10.9
35	1	0	0	0	1	1	1025	1981.25	1901.25		10.2	10.2
36	1	0	0	1	0	0	1050	1982.50	1902.50	**C**	9.5	9.5
37	1	0	0	1	0	1	1075	1983.75	1903.75		8.7	8.7

DEC NUM	A5	A4	A3	A2	A1	A0	CH # N	FREQ DL (MHZ)	FREQ UL (MHZ)	BLOCK	DL ATTN (dB) TYP	UL ATTN (dB) TYP
38	1	0	0	1	1	0	1100	1985.00	1905.00		8.0	8.0
39	1	0	0	1	1	1	1125	1986.25	1906.25		7.2	7.2
40	1	0	1	0	0	0	1150	1987.50	1907.50		6.9	6.9
41	1	0	1	0	0	1	1175	1988.75	1908.75		5.7	5.7
42	1	0	1	0	1	0	25	1931.25	1851.25	DEFAULT	5.0	5.0
43	1	0	1	0	1	1	25	1931.25	1851.25	DEFAULT	4.4	4.4
44	1	0	1	1	0	0	25	1931.25	1851.25	DEFAULT	3.9	3.9
45	1	0	1	1	0	1	25	1931.25	1851.25	DEFAULT	3.4	3.4
46	1	0	1	1	1	0	25	1931.25	1851.25	DEFAULT	3.0	3.0
47	1	0	1	1	1	1	25	1931.25	1851.25	DEFAULT	2.7	2.7
48	1	1	0	0	0	0	25	1931.25	1851.25	DEFAULT	2.3	2.3
49	1	1	0	0	0	1	25	1931.25	1851.25	DEFAULT	2.0	2.0
50	1	1	0	0	1	0	25	1931.25	1851.25	DEFAULT	1.8	1.8
51	1	1	0	0	1	1	25	1931.25	1851.25	DEFAULT	1.6	1.6
52	1	1	0	1	0	0	25	1931.25	1851.25	DEFAULT	1.4	1.4
53	1	1	0	1	0	1	25	1931.25	1851.25	DEFAULT	1.2	1.2
54	1	1	0	1	1	0	25	1931.25	1851.25	DEFAULT	1.0	1.0
55	1	1	0	1	1	1	25	1931.25	1851.25	DEFAULT	0.8	0.8
56	1	1	1	0	0	0	25	1931.25	1851.25	DEFAULT	0.6	0.6
57	1	1	1	0	0	1	25	1931.25	1851.25	DEFAULT	0.5	0.5
58	1	1	1	0	1	0	25	1931.25	1851.25	DEFAULT	0.35	0.35
59	1	1	1	0	1	1	25	1931.25	1851.25	DEFAULT	0.2	0.2
60	1	1	1	1	0	0	25	1931.25	1851.25	DEFAULT	0.1	0.1
61	1	1	1	1	0	1	25	1931.25	1851.25	DEFAULT	0.1	0.1
62	1	1	1	1	1	0	25	1931.25	1851.25	DEFAULT	0	0
63	1	1	1	1	1	1	25	1931.25	1851.25	DEFAULT	0	0

Figure X.Y cont

Programming is done by first selecting the mode (upper 2 digits, A6 & A7), then setting the desired value (lower 6 digits) and pressing the load button (SW2). The 48660 will automatically set the desired value. See Tables X.X and X.Y for values.

The frequency of the Down Link and Up Link are calculated as follows:

$$F_{DL} = 1930 \text{ MHz} + 0.05 * N$$
$$F_{UL} = 1850 \text{ MHz} + 0.05 * N$$

Where N is the Channel Number

Attenuation values are considered typical and need to be optimized once the 48660 is installed.

The 48660 Intelli BDA will remember the last programmed channel number and attenuation values and will tune to these values automatically upon subsequent power up initializations.

POWER CONTROL AND INTERMODULATION

Power control circuitry is provided to prevent excess output power and, thus, excess 3rd order intermodulation distortion (IMD). IMD levels are a function of the output power and the IP3 of the amplifier stages [IM = 3(Po) - 2(IP3)]. The FCC regulations specify the maximum IMD levels at -13 dBm. Each BDA is tested and set for maximum IMD levels of -13 dBm in either RF link. The resultant power setting is the "Usable Output Power" in the general specifications. However, the typical IMD for PCS 1900 is below -30 dBm.

The Power control circuitry senses output power. If the output power attempts to exceed the factory setting, generally due to strong input signals, the Power control circuitry introduces gain attenuation, maintaining output power to the preset limit [Pin + Gain - Attenuation = Pout]. When the input signal is too strong, the attenuation range of the Power Control circuitry is exceeded; the output power will increase beyond the factory setting. In this situation, it is likely that IMD levels will exceed -13 dBm. If this is expected to be a consistent problem, some input attenuation should be provided.

The yellow LEDs, "UL PWR and DL PWR", on the front panel will light up whenever the Power Control circuitry is active. The advantage of using Power control circuitry stage is two-fold. First, the dynamic range of the amplifier is increased. A wider range of input signal levels can be handled by the system. This advantage can also be stated in terms of gain. More gain can be put into the system to handle weak signals without risking premature compression and excessive intermodulation emissions due to stronger signals. The second significant advantage is that intermodulation products are kept to acceptable levels. As more channels become active, or as some signals become stronger, gain is reduced and total output power is kept constant.

REMOTE INTERFACE

TYPE OF SERVICE:

The intelliBDA is designed to be used on standard device telephone lines connected to the telephone line by means of a standard jack called the USOC RJ-11C (or USOC FJ45S). Connection to telephone company provided coin service (central office implemented systems) is prohibited. Connection to party lines service subject to state tariffs.

TELEPHONE COMPANY PROCEDURES:

The goal of the telephone company is to provide you with the best service it can. In order to do this; it may occasionally be necessary for them to make changes in their equipment, operations or procedures. These changes might affect your service or the operation of your equipment, the telephone company will give you notice, in writing, to allow you to make any changes necessary to maintain uninterrupted service.

In certain circumstances, it may be necessary for the telephone company to request information from you concerning the equipment, which you have connected to your telephone line. Upon request of the telephone company, provide the FCC registration number and the ringer equivalence number (REN); both of these items are listed on the equipment label. The sum of all of the RENs on your telephone lines should be less than five in order to assure proper service from the telephone company. In some cases, a sum of five may not be usable on a given line.

IF PROBLEM ARISE:

If any of your telephone equipment is not operating properly, you should immediately remove it from your telephone line, as it may cause harm to the telephone network. If the telephone company notes a problem, they may temporarily

discontinue service. When practical, they will notify you in advance of this disconnection. If advance notice is not feasible, you will be notified as soon as possible. When you are notified, you will be given the opportunity to correct the problem and be informed of your right to file a complaint with the FCC. Contact your telephone company if you have any questions about your phone line. In the event repairs are ever needed on the intelliBDA, Celwave or an authorized representative of Celwave should perform them. For information contact:

Celwave-Corvallis
4100 SW Research Way
Corvallis Oregon 97333-1066
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RF CONNECTIONS

The primary RF connections are made via two type "N" female connectors. The connector labeled "BASE STATION" must be connected to the antenna/system pointing towards the base station. The connector labeled "SERVICE AREA" must be connected to the antenna/system pointing into the service area.

AC / DC POWER

The 48660 comes with a standard 6 ft. US type NEMA 5-15P 3-wire male plug with phase, neutral, and safety ground wires. AC power is only used to supply a high-efficiency 24 VDC switching power supply. This supply has been thoroughly tested by Celwave for temperature capability, modulation effects, and harmonic coupling into the RF circuitry. All internal components are powered by 24 VDC.

{Power supply listings: UL E100527 Vol. 6 (USA), CSA LR64950-40 (Canada), TUV R9472032 (Europe), VDE NR84964 (Germany).} ****CHECK NEW LISTINGS!!!********

The 48660 Intelli BDA is fused to prevent further damage should the BDA fail. The fuse located in the AC receptacle housing. To replace, unplug power cord and with finger, apply slight downward pressure on the fuse door while pulling out. The door will open and the fuse can then be replaced with a 3.15 Amp 5 x 20 mm type fuse or equivalent. Never replace with a higher amperage rated fuse! This may cause damage to the 48660 Intelli BDA and void warranty.

WARNING: 120 VAC can be lethal. Never insert conductive objects into any opening.

The 48660 Intelli BDA has a 3 pin DC connector on the front panel. This can be used to supply DC power between +20 V and +28 V for battery back up applications. If AC power is present, the 48660 will not draw any current from this connector. Once AC power is removed, the Intelli BDA senses if there is a voltage present at this port and begins to draw current. If the voltage at this port ever drops below +20 Volts DC, the 48660 will turn itself off until AC power is restored.

The DC input is protected against short circuit, over voltage and reverse polarity conditions. It cannot be used to charge batteries. This DC input is fused with the same fuse as used in the AC Power receptacle housing. To access the DC fuse, first remove AC and DC power from the Intelli BDA, open shroud and with a fuse puller or equivalent tool, remove fuse located in bottom right corner of the Digital Board (See Figure X.X). Replace with a 3.15 Amp 5 x 20mm fuse or equivalent. Never replace with a higher amperage rated fuse!!! This may cause damage to the 48660 Intelli BDA and void warranty.

Testing at Celwave has shown that two, 12 V batteries in series, rated at 7 AH will power the 48660 for greater than 30 minutes.

ENVIRONMENTAL CONSIDERATIONS

Operating Temperature: -30^{o} C to +50^{o} C

Operation over 60^{o} C voids warranty.

Operation at case temperatures over 50^{o} C should be limited to 200 hours per year.

Humidity: Non-condensing up to 95% relative for 0^{o} C to 50^{o} C within full specified data.

PERIODIC MAINTENANCE

There is little maintenance in the 48660 Intelli BDA. As long as the unit is kept away from extreme temperatures, and moisture, it will provide long-term, carefree operation. Periodically, check the two type "N" RF connections for corrosion, strain damage, and tightness. Periodically, check the AC or DC power connections for integrity.

The 48660 Intelli BDA enclosure is intended for weather protected applications. Venting the enclosure increases the reliability but provides an entrance for moisture. It is also advisable to avoid a location with continuous high levels of sunlight exposure and/or excessively dirty and dusty environments.

Description	Manufacturer	Part Number	Notes
Mating connector for DC Connector	Switchcraft	TA3F or TA3FL	
Fuses--External AC and Internal DC	Various	Various	5 x 20mm 3.15 A Fast Acting
Telco Interconnect	Various	RJ-11 Plug	Std Tip & Ring Wired

SET UP AND INSTALLATION CONSIDERATIONS

BEFORE APPLYING AC POWER:

Make sure antennas are connected or the RF terminals are terminated!
Make sure amplifier is vertically mounted!
Antenna isolation must be 80 dB or greater to prevent oscillation!
Check the incoming spectrum to assure that no signals in the pass band are greater then -15 dBm!

ANTENNA ISOLATION

Proper implementation of the antennas is absolutely crucial to the repeater system. Several important issues must be considered when selecting and implementing the antennas. The most important consideration, besides the obvious concerns for gain and area of coverage, is the antenna isolation.

Base station to service area antenna isolation should be 80 dB. If the isolation is less, then gain ripple due to feedback is likely. Positive feedback sufficient for oscillation will overdrive one or both amplifier links and may eventually cause damage to the BDA.

High-gain (high directivity) antennas usually have significant isolation between front and back. Additional decoupling can be achieved by spatially separating the antennas. Generally, for in-building applications, with one antenna located outside and the other antenna located inside, the isolation is adequate. An isolation measurement is always recommended when possible.

The most direct way to measure the isolation is to inject a known signal into one antenna, and measure the coupled signal at the other antenna. This should be done across the applicable bandwidth to account for the frequency dependency of standing waves. Ordinarily, reciprocity would dictate that measuring the isolation between antenna 1 and antenna 2 is the same as the isolation measured between antenna 2 and antenna 1. However, the reflection paths for each antenna are likely different; therefore, the isolation measurements should be repeated in each link.

DIAGNOSTICS and TROUBLESHOOTING GUIDE

OPENING THE AMPLIFIER ELECTRONICS COMPARTMENT WILL NEGATE WARRANTY.

The diagnostics of the 48660 Intelli BDA can assist in troubleshooting an installation problem or determining if the BDA needs to be sent in for repair. In some situations, the shroud of the 48660 Intelli BDA may need to be opened to allow access to the Programming DIP Switches and/or DC Power fuse. Under no circumstances should the internal amplifier electronics subassembly be opened!

Front Panel LEDs:

There are 6 LED indicators on the front panel to indicate certain faults or modes of operation. Table X.2 describes these functions:

LED Name	Function
Power	Steady ON indicates AC power is present. Blinking ON/OFF indicates unit is powered from DC Connection
Fault	Normal OFF. ON indicates fault condition (TBD)
Synth Lock	Steady ON indicates synthesizer is in locked condition. Will blink momentarily when changing channels. OFF indicates synthesizer is not locked and a fault condition exists
Modem	ON indicates modem activity
UL Power	ON indicates Up Link Power Control Loop is active ie.) Attenuation is being applied to signal. During installation, the UL Attenuator should be adjusted to keep this LED OFF during normal operation
DL Power	ON indicates Down Link Power Control Loop is active ie.) Attenuation is being applied to signal. During installation, the DL Attenuator should be adjusted to keep this LED OFF during normal operation

Table X.2 LED Description

Gain or Coverage Reduction:

Reduced gain may indicate a device failure. The RED Fault LED will be lit. See FAULT MONITORING. If the BDA gain is low and neither the Red Fault nor Yellow DL or UL PWR LEDs are lit then the unit may have faulty internal connections or filter detuning. Return unit for repair.

The most likely cause of system gain reduction is corruption of connections or cabling somewhere in the RF path. Check all cabling for integrity. Another possible cause of gain reduction is a movement of the antenna, or a significant change in the surroundings leading to loss of RF signal.

Excessive Intermodulation or Spurious:

Because the Intelli-BDA is single channel, excessively strong out of band signals are attenuated out early in the amplifier chains. Excessive intermodulation products are usually contributed by the in band signal being too strong. To reduce this, simply adjust the attenuator setting for that particular link until the LED indicating the power for that link is extinguished.

Another possible source of a large spurious signal is amplifier oscillation. The amplifiers will only oscillate if the antenna isolation is insufficient. It is also possible that "dirty" connections could be causing excessive noise output. This would be particularly evident while wiggling cables and connectors.

ORDERING & RETURNING FOR REPAIR

Contact Celwave Order Entry at 1-800-321-4700 for a customer service request number (CSR). Be prepared to provide the model number, serial number of the BDA as well as a description of the symptoms of the problem. Typical turn around time for repairs is two weeks. Warranty repairs will be given the highest priority.

Send unit, freight-paid with the Return Authorization Number on the outside of the package to:

Celwave Corvallis
4100 SW Research Way
Corvallis Oregon 97333-1066

LIMITED WARRANTY

The Seller warrants that, at the time of shipment, the products manufactured by the Seller are free from defects in material and workmanship. The Seller's obligation under this warranty is limited to replacement or repair of such products within one year from date of shipment. No material is accepted for replacement or repair without written authority of the Seller. Replacement or repair is made only after an examination at the Seller's plant shows defective material or workmanship at the time of manufacture. The Buyer must prepay all shipping charges on the returned material. The Seller is in no event liable for consequential damages, installation costs or other costs of any nature as a result of the use of the products manufactured by the Seller, whether used in accordance with instructions or not. The Seller is not liable for replacement of any product damaged by lightning.

THIS WARRANTY IS IN LIEU OF ALL OTHERS, EITHER EXPRESSED OR IMPLIED. No representative is authorized to assume for the Seller any other liability in connection with the Seller's products.

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