UB-530

Breakout Panel
Installation and Operation Manual

Part Number MN/UB530.IOM Revision 2

UB-530

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Installation and Operation Manual

Comtech EF Data is an ISO 9001
Registered Company.

Part No. MN/UB530.IOM
Revision 2
June 2, 2004

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For more information regarding the warranty policies, see Warranty Policy, p. viii.

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About this Manual

This manual provides installation and operation information for the Comtech EF Data UB-530 Breakout Panel. This a technical document intended for earth station engineers, technicians, and operators responsible for the operation and maintenance of the breakout panel.

Conventions and References

Cautions, Warnings, and Important Notes

CAUTION indicates a hazardous situation that, if not avoided, may result in minor or moderate injury. CAUTION may also be used to indicate other unsafe practices or risks of property damage.

WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

Indicates information critical for proper equipment function.

Metric Conversion

Metric conversion information is located on the inside back cover of this manual. This information is provided to assist the operator in cross-referencing English to Metric conversions.

Trademarks

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Comments and suggestions regarding the content and design of this manual will be appreciated. To submit comments, please contact the Comtech EF Data Technical Publication Department: techpub@comtechefdata.com

Overview of Changes to Previous Edition

Changes made to Revision 1 include:

General	Changed EIA- to RS- designators. Removed references to AC/DC power.
Chapter 1	Added reference to Standard 37-pin for RS-422 connector.`
Chapter 2	Revised pin tables.

Electrical Safety

The UB-530 Breakout Panel does not require electrical power nor does it incorporate any fuses.

Environmental

The breakout panel must not be operated in an environment where the unit is exposed to extremes of temperature outside the ambient range 0 to 50°C (32° to 122°F), precipitation, condensation, or humid atmospheres above 95% RH, altitudes (un-pressurised) greater than 2000 metres, excessive dust or vibration, flammable gases, corrosive or explosive atmospheres.

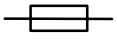
Operation in vehicles or other transportable installations that are equipped to provide a stable environment is permitted. If such vehicles do not provide a stable environment, safety of the equipment to EN60950 may not be guaranteed.

Installation

Installation:

The installation and connection to the line supply must be made in compliance to local or national wiring codes and regulations.

International Symbols:

Symbol	Definition		Symbol	Definition
~	Alternating Current			Protective Earth
	Fuse			Chassis Ground

Telecommunications Terminal Equipment Directive

In accordance with the Telecommunications Terminal Equipment Directive 91/263/EEC, this equipment should not be directly connected to the Public Telecommunications Network.

EMC (Electromagnetic Compatibility)

In accordance with European Directive 89/336/EEC, the breakout panel has been shown, by independent testing, to comply with the following standards:

Emissions: EN 55022 Class B - Limits and methods of measurement of radio interference characteristics of Information Technology Equipment.

(Also tested to FCC Part 15 Class B)

Immunity: EN 50082 Part 1 - Generic immunity standard, Part 1: Domestic, commercial and light industrial environment.

Additionally, the breakout panel has been shown to comply with the following standards:

EN 61000-3-2	Harmonic Currents Emission
EN 61000-3-3	Voltage Fluctuations and Flicker
EN 61000-4-2	ESD Immunity
EN 61000-4-4	EFT Burst Immunity
EN 61000-4-5	Surge Immunity
EN 61000-4-6	RF Conducted Immunity
EN 61000-4-8	Power frequency Magnetic Field Immunity
EN 61000-4-9	Pulse Magnetic Field Immunity
EN 61000-4-11	Voltage Dips, Interruptions, and Variations Immunity
EN 61000-4-13	Immunity to Harmonics

In order that the breakout panel continues to comply with these standards, observe the following instructions:

- Connections to the transmit and receive IF ports (Type N or Type F connectors) should be made using a good quality coaxial cable - for example 50 Ω or 75 Ω.
- All 'D' type connectors attached to the rear panel must have back-shells that provide continuous metallic shielding. Cable with a continuous outer shield (either foil or braid, or both) must be used, and the shield must be bonded to the backshell.
- The equipment must be operated with its cover on at all times. If it becomes necessary to remove the cover, the user should ensure that the cover is correctly re-fitted before normal operation commences.

Safety Compliance

EN 60950

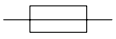
This equipment meets the Safety of Information Technology Equipment specification as defined in EN60950.

Low Voltage Directive (LVD)

The following information is applicable for the European Low Voltage Directive (EN60950):

<HAR>	Type of power cord required for use in the European Community.
	CAUTION: Double-pole/Neutral Fusing. ACHTUNG: Zweipolige bzw. Neutralleiter-Sicherung.

International Symbols:

Symbol	Definition
	Alternating Current.
	**Fuse.**

Symbol	Definition
	**Protective Earth.**
	**Chassis Ground.**

Note: For additional symbols, refer to “Cautions” listed earlier in this preface. Applicable testing is routinely performed as a condition of manufacturing on all units to ensure compliance with safety requirements of EN60950.

Warranty Policy

This Comtech EF Data product is warranted against defects in material and workmanship for a period of 12 months from the date of shipment. During the warranty period, Comtech EF Data will, at its option, repair or replace products that prove to be defective.

For equipment under warranty, the customer is responsible for freight to Comtech EF Data and all related custom, taxes, tariffs, insurance, etc. Comtech EF Data is responsible for the freight charges **only** for return of the equipment from the factory to the customer. Comtech EF Data will return the equipment by the same method (i.e., Air, Express, Surface) as the equipment was sent to Comtech EF Data.

Limitations of Warranty

The foregoing warranty shall not apply to defects resulting from improper installation or maintenance, abuse, unauthorized modification, or operation outside of environmental specifications for the product, or, for damages that occur due to improper repackaging of equipment for return to Comtech EF Data.

No other warranty is expressed or implied. Comtech EF Data specifically disclaims the implied warranties of merchantability and fitness for particular purpose.

Exclusive Remedies

The remedies provided herein are the buyer's sole and exclusive remedies. Comtech EF Data shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

Disclaimer

Comtech EF Data has reviewed this manual thoroughly in order that it will be an easy-to-use guide to your equipment. All statements, technical information, and recommendations in this manual and in any guides or related documents are believed reliable, but the accuracy and completeness thereof are not guaranteed or warranted, and they are not intended to be, nor should they be understood to be, representations or warranties concerning the products described. Further, Comtech EF Data reserves the right to make changes in the specifications of the products described in this manual at any time without notice and without obligation to notify any person of such changes.

If you have any questions regarding your equipment or the information in this manual, please contact the Comtech EF Data Customer Support Department.

Chapter 1. Introduction

The UB-530 (Figure 1-1) provides industry standard interface connectors for access to the modem's data, clock, control, and alarm signals via a 50-pin D-sub connector. It functions as a universal breakout panel for IDR, IBS, or D&I operations all in one, rack-mountable unit.

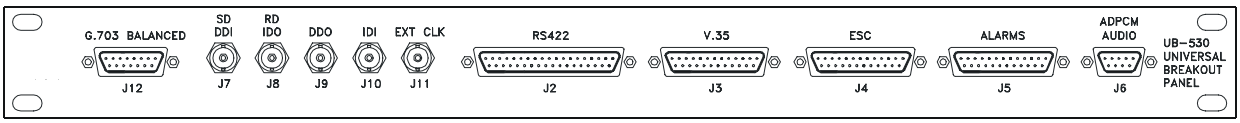


Figure 1-1. UB-530 Breakout Panel

This breakout panel can be used in 1:1 switching configurations.

Major UB-530 features include:

- Convenient access to the SDM-308 Rev. 4 ESC through a standard 25-pin D connector.
- Access to the 1/15 IBS overhead order wire, alarms, T1/E1, RS-422/449, and V.35 data interfaces. The T1/E1 can be configured for balanced or unbalanced DATA I/O signals through rear panel switches.
- Standardized interfaces for D&I data. Both balanced and unbalanced interfaces for drop DATA I/O and insert DATA I/O are provided, and are selectable through rear panel DIP switches.
- Standard 25-pin D connector pinout for V.35 or RS-530 signals
- Standard 37-pin D connector for RS-422 signals (RS-449 compatable).

The UB-530 is a standard one unit (1U) rack-mountable chassis.The unit consists of a printed circuit board, connectors, and switches for breakout panel operation. The connectors and switches are located at the front and rear panels.

The UB-530 consists of the following assemblies:

Assembly	Part #
Chassis	PL/5809
Printed Circuit Board	PL/5808

The electrical specifications for the UB-530 meet or exceed the electrical requirements of the interfacing modem.

Refer to Chapter 2 for connector and switch information.

Chapter 2. Connectors and Switches

Connections between the breakout panel and other equipment are made through front and rear panel connectors. Refer to Figure 2-1 for an illustration of the UB-530.

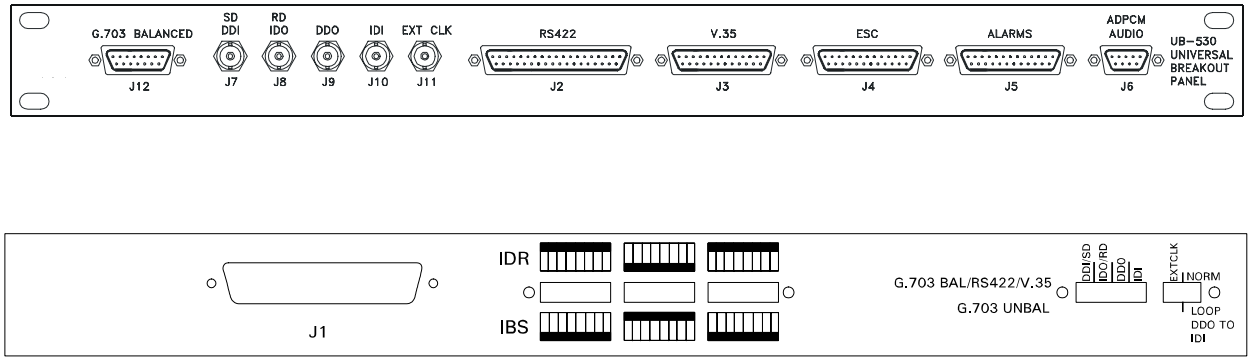


Figure 2-1. UB-530 Front and Rear Views

2.1 Switches

The five configuration DIP switches located on the rear of the breakout panel are used for selecting IBS/IDR modes of operation, and balanced or unbalanced signals, and control of D&I looping.

The RS-422 multi-functional connector (J2) on the front panel may be used for standard (non-overhead), IBS, or IDR (ESC) mode. SW1, SW2, and SW3 are used in selecting IBS or IDR mode of operation.

SW4 and SW5 are used to select balanced or unbalanced inputs and outputs.

Refer to Table 2-1 for UB-530 configuration switch settings. The locations of the switches are shown in Figure 2-1.

Table 2-1. UB-530 Configuration Switch Selections

Switch	ON (Down) Position	OFF (Up) Position
SW1-All	IBS	IDR
SW2-All	IDR	IBS
SW3-All	IBS	IDR
SW4-All	Unbalanced Data & Clock	Balanced Data & Clock
SW5-1	Unbalanced EXT Clock	Balanced EXT Clock
SW5-2	Unbalanced EXT Clock	Balanced EXT Clock
SW5-3	Drop out/Insert in loop	Drop out/Insert in normal
SW5-4	Drop out/Insert in loop	Drop out/Insert in normal

2.2 Connectors

The locations of the connectors are shown in Figure 2-1. Refer to Table 2-2 for a list of UB-530 connectors.

Table 2-2. UB-530 Breakout Panel Connectors

Ref. Desig.	Type	Interface Function
J1	50-pin D socket	Modem DATA I/O
J2	37-pin D socket	RS-422 or 8 kbps ESC (IDR)
J3	25-pin D socket	V.35 or RS-530
J4	25-pin D socket	ESC
J5	25-pin D socket	Alarms (IBS and IDR)
J6	9-pin D socket	ADPCM Audio
J7	BNC	Unbalanced Drop Data Input/SD
J8	BNC	Unbalanced Insert Data Output/RD
J9	BNC	Unbalanced Drop Data Output
J10	BNC	Unbalanced Inset Data Input
J11	BNC	Unbalanced External Clock
J12	15-pin D socket	Balanced G.703

2.2.1 Modem Data I/O (J1)

The modem data I/O connection is a 50-pin D connector located at the rear of the breakout panel. Screw locks are provided for mechanical security of the mating connector.

This connector is used to interface all signals to and from the modem. The type of signal will depend on the configuration of the modem and panel. The UB-530 supports the following configuration types and interface signals:

- IBS
- IDR
- D&I
- G.703
- V.35
- RS-422
- RS-232
- ASYNC
- Flex MUX

2.2.1.1 IBS Interface (J1)

Signal Function	Name	Pin #
Ground	GND	1, 2
External clock	EXC–A EXC–B	35 19
Serial clock TX	SCT/ST–A SCT/ST–B	21 22
ESC terrestrial TX data	ESC TXD–A ESC TXD–B	5 4
Send data	SD–A SD–B	37 38
T1E1 send data	T1E1 SD–A T1E1 SD–B	34 18
ESC terrestrial RX data	ESC RXD–A ESC RXD–B	7 6
Receive data	RD–A RD–B	39 40
T1E1 receive data	T1E1 RD–A T1E1 RD–B	36 20
Serial clock RX	SCR/RT–A SCR/RT–B	23 24
RS-422 RX octet	RS422 RXO–A RS422 RXO–B	8 9
Data set ready	DSR/DM–A DSR/DM–B	41 48
Primary alarm	PRI–C PRI–NO PRI–NC	10 43 27
Secondary alarm	SEC–C SEC–NO SEC–NC	11 44 28
Serial clock RX	SCTE/TT–A SCTE/TT–B	12 13
Request to send	RTS–A RTS–B	45 29
RX line signal detect	RLSD/RR–A	46
Receiver ready	RR–B	30
RS-422 TX octet	RS-422 TXO–A RS-422 TXO–B	14 15
Clear to send	CTS–A CTS–B	47 31
Data mode	DM–B	32

2.2.1.2 IDR Interface (J1)

Signal Function	Name	Pin #
Ground	GND	1, 2
TX octet output	8K TXO–A 8K TXO–B	4 5
TX data	8K TXD–A 8K TXD–B	37 38
TX clock	8K TXC–A 8K TXC–B	21 22
RX octet	8K RXO–A 8K RXO–B	6 7
RX data	8K RXD–A 8K RXD–B	39 40
RX clock	8K RXC–A 8K RXC–B	23 24
Send data	SD–A SD–B	34 18
Receive data	RD–A RD–B	36 20
External clock	EXC–A EXC–B	35 19
Backward alarm 1 output	BWO1–C BWO1–NO BWO1–NC	8 41 25
Backward alarm 2 output	BWO2–C BWO2–NO BWO2–NC	9 42 26
Backward alarm 3 output	BWO3–C BWO3–NO BWO3–NC	10 43 27
Backward alarm 4 output	BWO4–C BWO4–NO BWO4–NC	11 44 28
Backward alarm input	BWI–1 BWI–2 BWI–3 BWI–4	12 13 14 15
ADPCM1 audio input	A1I–A A1I–B	45 29
ADPCM1 audio output	A1O–A A1O–B	46 30
ADPCM2 audio input	A2I–A A2I–B	47 31
ADPCM2 audio output	A2O–A A2O–B	48 32
Demodulator fault	DF–COM DF–NO	16 50
Deferred maintenance alarm	DMA	17

2.2.1.3 D&I Interface (J1)

Signal Function	Name	Pin #
Ground	GND	1, 2
Drop data input	DDI–A DDI–B	34 18
External clock	EXC–A EXC–B	35 19
Insert data output	IDO–A IDO–B	36 20
Drop data output	DDO–A DDO–B	37 38
Insert data input	IDI–A IDI–B	39 40
Terrestrial TX data	TER–TXDAT	5
Terrestrial RX data	TER–RXDAT	7
Primary	PRI–COM PRI–NO PRI–NC	10 43 27
Secondary	SEC–COM SEC–NO SEC–NC	11 44 28
Data set ready	DSR	48

2.2.2 RS-422 (IBS) or 8 kbps ESC (IDR) (J2)

The RS-422 or 8 kbps ESC (IDR) connection is a 37-pin D connector located at the front of the breakout panel. Screw locks are provided for mechanical security of the mating connector.

The connection will operate as either an IBS (standard RS-422) or an IDR (8-kbps ESC) I/O, depending on the configuration switch settings on the rear panel (see Section 2.1).

2.2.2.1 IBS/RS-422 (J2)

Signal Function	Name	Pin #
Ground	GND	1, 19, 20, 37
TX octet	TXO–A TXO–B	3 21
Send data	SD–A SD–B	4 22
Send timing	ST–A ST–B	5 23
Receive data	RD–A RD–B	6 24
Request to send	RTS–A RTS–B	7 25
Receive timing	RT–A RT–B	8 26
Clear to send	CTS–A CTS–B	9 27
Data mode	DM–A DM–B	11 29
Receiver ready	RR–A RR–B	13 31
External clock	EXC–A EXC–B	15 33
RX octet	RXO–A RXO–B	16 34
Terminal timing	TT–A TT–B	17 35

2.2.2.2 IDR 8-kbps ESC (J2)

Signal Function	Name	Pin #
Ground	GND	1, 19, 20, 37
TX octet	TXO–A TXO–B	3 21
TX data	TXD–A TXD–B	4 22
TX clock	TXC–A TXC–B	5 23
RX data	RXD–A RXD–B	6 24
Request to send/ Clear to send *(see note)*	RTS–CTS–A RTS–CTS–B	7, 9 25, 27
RX clock	RXC–A RXC–B	8 26
RX octet	RXO–A RXO–B	15 33

Note: RTS/CTS lines are looped together at the connector

2.2.3 V.35, RS-530 (J3)

The V.35 connection is a 25-pin D connector located at the front of the breakout panel. Screw locks are provided for mechanical security of the mating connector.

	V.35		RS-530	
Signal Function	**Name**	**Pin #**	**Name**	**Pin #**
Ground	GND	1, 7	GND	1,7
Send data	SD–A SD–B	2 14	SD–A SD–B	2 14
Serial clock TX	SCT–A SCT–B	15 12	ST-A ST-B	15 12
Receive data	RD–A RD–B	3 16	RD–A RD–B	3 16
Request to send	RTS	4	RS-A RS-B	4 19
Serial clock RX	SCR–A SCR–B	17 9	RT-A RT-B	17 9
Clear to send	CTS	5	CS-A CS-B	5 13
Data set ready	DSR	6	DM-A DM-B	6 22
RX line signal detect	RLSD	8	RLSD-A RLSD-B	8 10
External data clock	EXC–A EXC–B	20 23	MC-A MC-B	20 23
Serial clock TX external	SCTE–A SCTE–B	24 11	TT-A TT-B	24 11
Modulator Fault	MF	25	MF	25
Demodulator Fault	DF	21	DF	21

2.2.3.1 Adapting the V.35 25-Pin D Connector on the UB-530 to the UB-300 Pinout

The connectors on the UB-530 and UB-300 Universal Breakout Panels are identically wired, except for the 25-pin D connector which, is used for the V.35 data interface. The UB-530 uses a standard RS-530 pinout, while the UB-300 pinout is non-standard. The following information describes how to adapt the UB-530 to the UB-300 pinout.

An adapter is added to the UB-530 breakout panel that converts to the UB-300 pinout. Figure 2-2 illustrates the adapter that plugs directly into J3 of the UB-530, and Table 2-3 provides the wiring information for conversion from RS-530 to the UB-300 pinout.

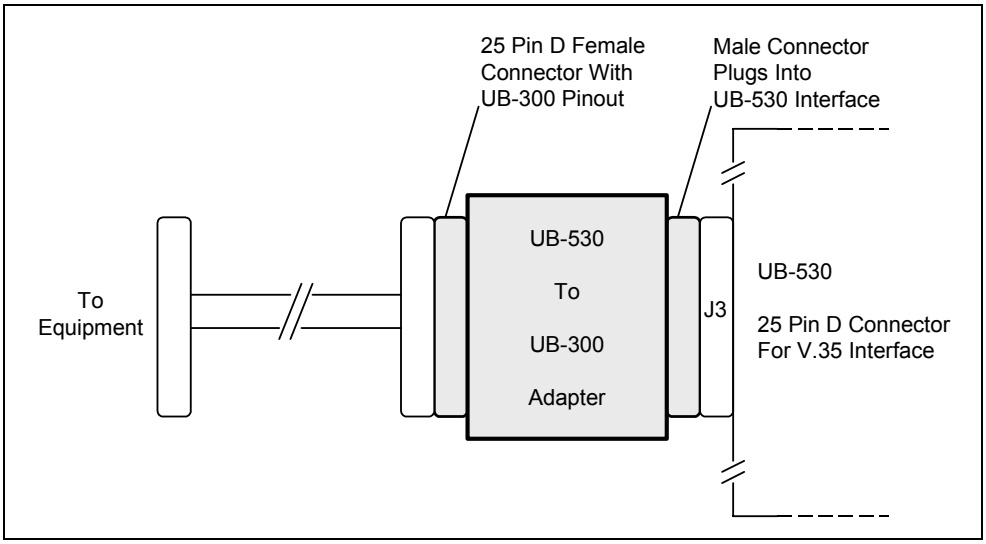


Figure 2-2. UB-530 To UB-300 Adapter For 25-Pin V.35 Connector (J3)

These adapters are available from several sources. The ones listed below are solder-less and make conversion quick and easy:

Nomenclature	Web Site	Model/Part No.
Patton Electronics Company (tel: 301 975 1000),	(http://ww.patton.com):	Model 8X-MF
B&B Electronics (tel: 815 433 5100),	(http://www.bb-elec.com):	232SMFJB

Table 2-3. Adapter Pinout For UB-530 To UB-300 Connection

25-Pin D Connector					
Pin #	**V.35 (RS-530)**	**To**	**Pin #**	**V.35 (UB-300)**	**Notes**
1	SHLD		1	SHLD	
2	SD-A		14	SD-A	
3	RD-A		16	RD-A	
4	RTS-A		4	RTS	
5	CTS-A		5	CTS	
6	DSR-A		6	DSR	
7	SIGGND		7	SIGGND	
8	RLSD-A		8	RLSD	
9	SCR-B		17	SCR-B	
10	RLSD-B		10		1
11	SCTE-B		24	SCTE-B	
12	SCT-B		15	SCT-B	
13	CTS-B		13		1
14	SD-B		2	SD-B	
15	SCT-A		18	SCT-A	
16	RD-B		3	RD-B	
17	SCR-A		19	SCR-A	
18			11		
19	RTS-B		9		1
20	MC-A		22	MC-A (EXC-A)	2
21	DF		21	DF	3
22	DSR-B		12		1
23	MC-B		23	MC-B (EXC-B)	2
24	SCTE-A		25	SCTE-A	
25	MF		20	MF	3

Notes:

1. These signals are used for RS-530 (RS-422) and not required for V.35 which uses only the “A” side of the signals.
2. Use the MASTER (MC or EXC) clock for EXTERNAL clock input. This clock input should equal the data rate unless the Asymmetrical Loop Timing Option (ASLT) is available. The ASLT option allows selection of different clock rates that vary from the digital data rate. Refer to the Utility/Modem Type/Modem Options menu for the ASLT option information.
3. MF and DF are fault indication signals from the modem and are not V.35 or RS-530 standard signals.

2.2.4 Engineering Service Channel (J4)

The Engineering Service Channel (ESC) connection is a 25-pin D connector located at the front of the breakout panel. Screw locks are provided for mechanical security of the mating connector.

Signal Function	Name	Pin #
Ground	GND	1, 7
Transmit data	TXD–A TXD–B	2 14
Transmit clock	TXCLK	15
Receive data	RXD–A RXD–B	3 16
Request to send/ Clear to send *(see note)*	RTS/CTS	4, 5
Receive clock	RXCLK	17
Terrestrial ESC DSR	TERESESCDSR	6

Note: RTS/CTS lines are looped together at the connector.

2.2.5 Alarms (J5)

The alarms connection is a 25-pin D connector located at the front of the breakout panel. The alarms interface is used to provide FORM C contact closures for the purpose of alarm reporting. FORM C contacts ratings are:

- 1A at 24 VDC
- 500 mA at 120 VAC

A connection between the Common (C) and the Normally Open (NO) contacts indicates no fault. The alarms interface will operate either in an IBS or an IDR mode, depending on the configuration switch settings on the rear panel (see Section 2.1).

2.2.5.1 IBS Alarms (J5)

Signal Function	Name	Pin #
Ground	GND	14
Primary alarm	PRI–C PRI–NO PRI–NC	5 18 6
Secondary alarm	SEC–C SEC–NO SEC–NC	19 7 20

2.2.5.2 IDR Alarms (J5)

Signal Function	Name	Pin #
Ground	GND	14
Backward alarm 1 output	BWO1–C BWO1–NO BWO1–NC	2 15 3
Backward alarm 2 output	BWO2–C BWO2–NO BWO2–NC	16 4 17
Backward alarm 3 output	BWO3–C BWO3–NO BWO3–NC	5 18 6
Backward alarm 4 output	BWO4–C BWO4–NO BWO4–NC	19 7 20
Demodulator fault	DF–COM DF–NO	8 21
Deferred maintenance alarm	DMA	9
Backward alarm 1 input	BWI–1	22
Backward alarm 2 input	BWI–2	10
Backward alarm 3 input	BWI–3	23
Backward alarm 4 input	BWI–4	11

2.2.6 ADPCM Audio (J6)

The ADPCM audio connection is a 9-pin D connector located at the front of the breakout panel. Screw locks are provided for mechanical security of the mating connector.

Audio Signal Function	Name	Pin #	64k Data (RS422)
Ground	GND	3	Ground
ADPCM1 audio input	A1I–A A1I–B	1 6	SDA (IN) SDB (IN)
ADPCM1 audio output	A1O–A A1O–B	2 7	RTA (OUT) RTB (OUT)
ADPCM2 audio input	A2I–A A2I–B	8 4	STA (OUT) STB (OUT)
ADPCM2 audio output	A2O–A A2O–B	9 5	RDA (OUT) RDB (OUT)

2.2.7 Drop Data Input/Send Data (J7)

The connection for the unbalanced drop data input/send data interface is a BNC connector located at the front of the breakout panel. For unbalanced operation, the configuration switches on the rear of the panel must be set correctly (see Section 2.1).

2.2.8 Insert Data Output/Receive Data (J8)

The connection for the unbalanced insert data output/receive data interface is a BNC connector located at the front of the breakout panel. For unbalanced operation, the configuration switches on the rear of the panel must be set correctly (see Section 2.1).

2.2.9 Drop Data Output (J9)

The connection for the unbalanced drop data output interface is a BNC connector located at the front of the breakout panel. For unbalanced operation, the configuration switches on the rear of the panel must be set correctly (see Section 2.1).

2.2.10 Insert Data Input (J10)

The connection for the unbalanced insert data input interface is a BNC connector located at the front of the breakout panel. For unbalanced operation, the configuration switches on the rear of the panel must be set correctly (see Section 2.1).

2.2.10 External Clock (J11)

The connection for the unbalanced external clock interface is a BNC connector located at the front of the breakout panel. This connection is used for clocking data out of the buffer. For unbalanced operation, the configuration switches on the rear of the panel must be set correctly (see Section 2.1).

2.2.11 Balanced G.703 Interface (J12)

The connection for the balanced G.703 interface is a 15-pin socket D connector located at the front of the breakout panel. Screw locks are provided for the mechanical security of the mating connector. For balanced operation, the configuration switches on the rear of the panel must be set correctly (see Section 2.1).

Signal Function	Name	Pin #
Ground	GND	2, 4
Drop data input/SD	DDI–A	1
	DDI–B	9
Insert data output/RD	IDO–A	3
	IDO–B	11
Drop data output	DDO–A	12
	DDO–B	5
Insert data input	IDI–A	13
	IDI–B	6
External clock	EXC–A	7
	EXC–B	8

METRIC CONVERSIONS

Units of Length

Unit	Centimeter	Inch	Foot	Yard	Mile	Meter	Kilometer	Millimeter
1 centimeter	—	0.3937	0.03281	0.01094	6.214×10^{-6}	0.01	—	—
1 inch	2.540	—	0.08333	0.2778	1.578×10^{-5}	0.254	—	25.4
1 foot	30.480	12.0	—	0.3333	1.893×10^{-4}	0.3048	—	—
1 yard	91.44	36.0	3.0	—	5.679×10^{-4}	0.9144	—	—
1 meter	100.0	39.37	3.281	1.094	6.214×10^{-4}	—	—	—
1 mile	1.609×10^{5}	6.336×10^{4}	5.280×10^{3}	1.760×10^{3}	—	1.609×10^{3}	1.609	—
1 mm	—	0.03937	—	—	—	—	—	—
1 kilometer	—	—	—	—	0.621	—	—	—

Temperature Conversions

Unit	° Fahrenheit	° Centigrade
32° Fahrenheit	—	0 (water freezes)
212° Fahrenheit	—	100 (water boils)
-459.6° Fahrenheit	—	273.1 (absolute 0)

Formulas
C = (F - 32) * 0.555
F = (C * 1.8) + 32

Units of Weight

Unit	Gram	Ounce Avoirdupois	Ounce Troy	Pound Avoir.	Pound Troy	Kilogram
1 gram	—	0.03527	0.03215	0.002205	0.002679	0.001
1 oz. avoir.	28.35	—	0.9115	0.0625	0.07595	0.02835
1 oz. troy	31.10	1.097	—	0.06857	0.08333	0.03110
1 lb. avoir.	453.6	16.0	14.58	—	1.215	0.4536
1 lb. Troy	373.2	13.17	12.0	0.8229	—	0.3732
1 kilogram	1.0×10^{3}	35.27	32.15	2.205	2.679	—

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