

Generic Avionics Backplane using Quadradial Insert Connectors

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Goals

- Reduce costs of avionics system development
 - Through significant reduction of NRE and
 - Through standardization of avionic internal electrical interfaces and mechanical interfaces
- For electrical interfaces *by* adopting:
 - serial communications interface
 - single voltage power distribution
 - minimal set of commonly used signals
 - Interconnection through a star architecture
 - Common card – HUB
 - User card – NODE
- For mechanical interfaces *by* adopting:
 - modular and variable length slot mechanical enclosure concept using card frames (slices) where
 - each Printed Wiring Board (PWB) includes its own portion of the mechanical chassis

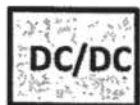
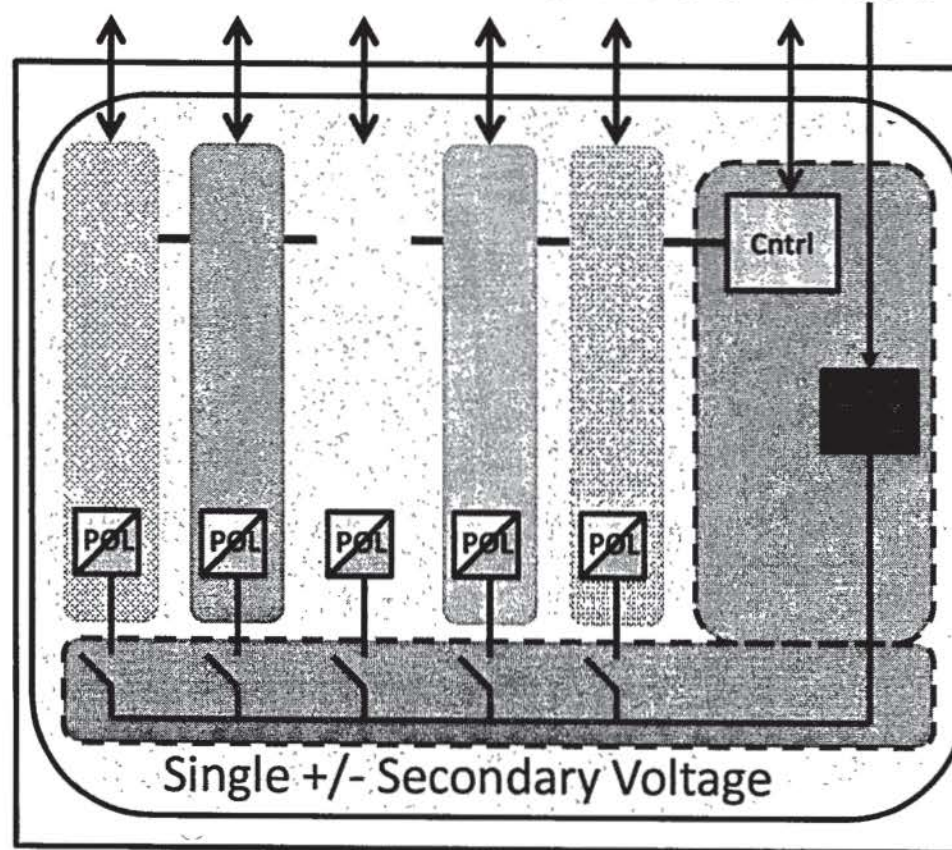
Benefits

- NASA builds a board; ESA or JAXA builds a board; and industry supplies boards that can all connect together to form a subsystem
- Increased data throughput on subsystem level
 - Asynchronous data flows
 - Concurrent data flows
- Lower mass and volume over parallel bus design
- 100% EMI shielded
- No strict requirements for mechanical enclosure design
 - Card frames are standalone mechanical designs
 - Not constrained by distances between boards (board height)
 - Easy mechanical tolerance constraints for harness interconnects
- Support multiple redundancy schemes – Single String, Dual Redundant or Cross-Strapped Redundant

Major System Requirements

- High speed communication links
 - Compatibility with high speed (gigabit) serial protocol
- Power distribution
- Reliability
 - Card-to-card isolation
 - Support Redundancy schemes
- Ease of implementation
- Ease of expansion
 - Up to 5 NODE cards in same chassis (6 or 7 cards total including HUB card(s))
 - Front panel expansion possible

Generic Avionics Box



= DC/DC Power Converter



= Linear or Switching



= Primary Power



= Secondary Power



= Vehicle Control Data Network



= Internal Data Network



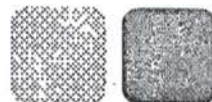
= Electronics enclosure



= Functional partition



= Common slice



= Subsystem slice

Typically Used Backplane Signals

- Signals list derived from experience over many missions:
 - Data
 - Power
 - Clock
 - Telemetry
 - Handshaking/ Auxiliary

Traditional Approach

- **Electrical**
 - Custom and/or Euro Card form factor (typically 6U or 3U)
 - Parallel Printed Wiring Board backplane (typically PCI)
 - Some custom signals added to PCI signal set
- **Mechanical**
 - Custom Enclosure design with card faceplate integrated with card

Proposed System Description

Peer-to-Peer Network

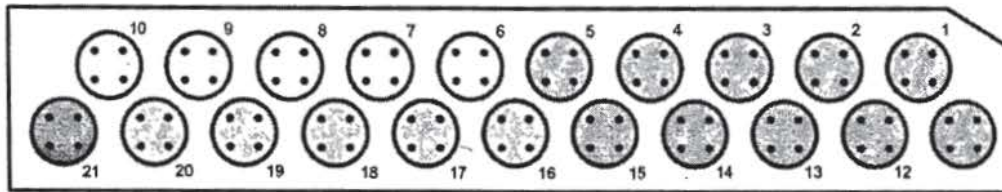
- Data
 - Full-duplex SERDES communications signaling up to 4 GHz
 - AC coupled
 - e.g., SpaceWire; SpaceFibre; PCI Express, compatible
- Power
 - Switched power distribution from HUB
 - Hot-pluggable card system
 - Up to 3 Amps per NODE (after derating)
- Clock
 - Individually distributed from HUB
 - Flexibility for NODE to eliminate on-card oscillator
 - Zero frequency drift
 - Superior events synchronization
- Dedicated analog telemetry
 - Temperature telemetry (1 thermistor per NODE card)
 - Ability to eliminate the analog Data Acquisition System (DAS) for each card
 - Only multiplexer for analog signals required
- Handshaking/ Auxiliary
 - System configuration – indicates presence and activity of NODE card
 - Master/ Slave – indicates which HUB is prime and which is redundant

Proposed System Highlights

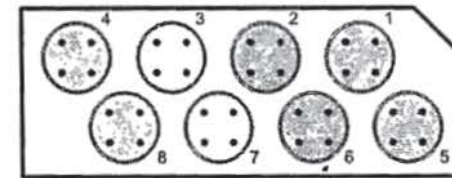
- Ease of implementation
 - 1 large connector per CPU (HUB) card
 - 1 small connector per load (NODE) card
- System reliability
 - Single string, or
 - Dual redundancy, or
 - Cross-redundancy
 - Double processing/comm rate when 2 Hub cards are plugged in
- System expandability
 - Can control Dual/Cross redundant subsystems






Suggested Functional Arrangement

HUB Connector



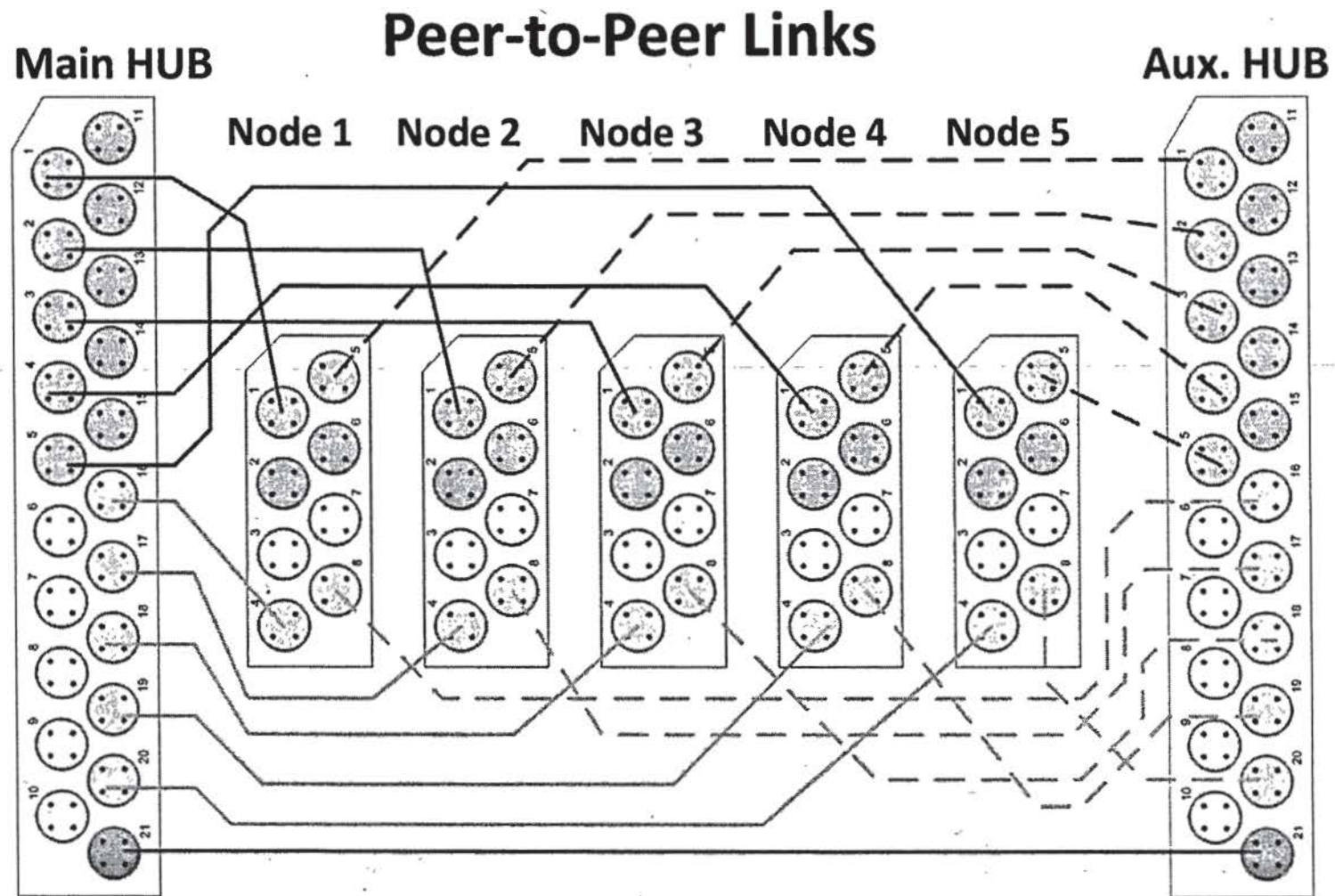
NODE Connector



-  Analog Telemetry (Node → Hub)
-  Power Distribution (Hub → Node)
-  Clock Distribution (Hub → Node)
-  Node Communication (Hub ↔ Node)
-  Cross Communication (Hub ↔ Hub)

Suggested Bus Architecture #1

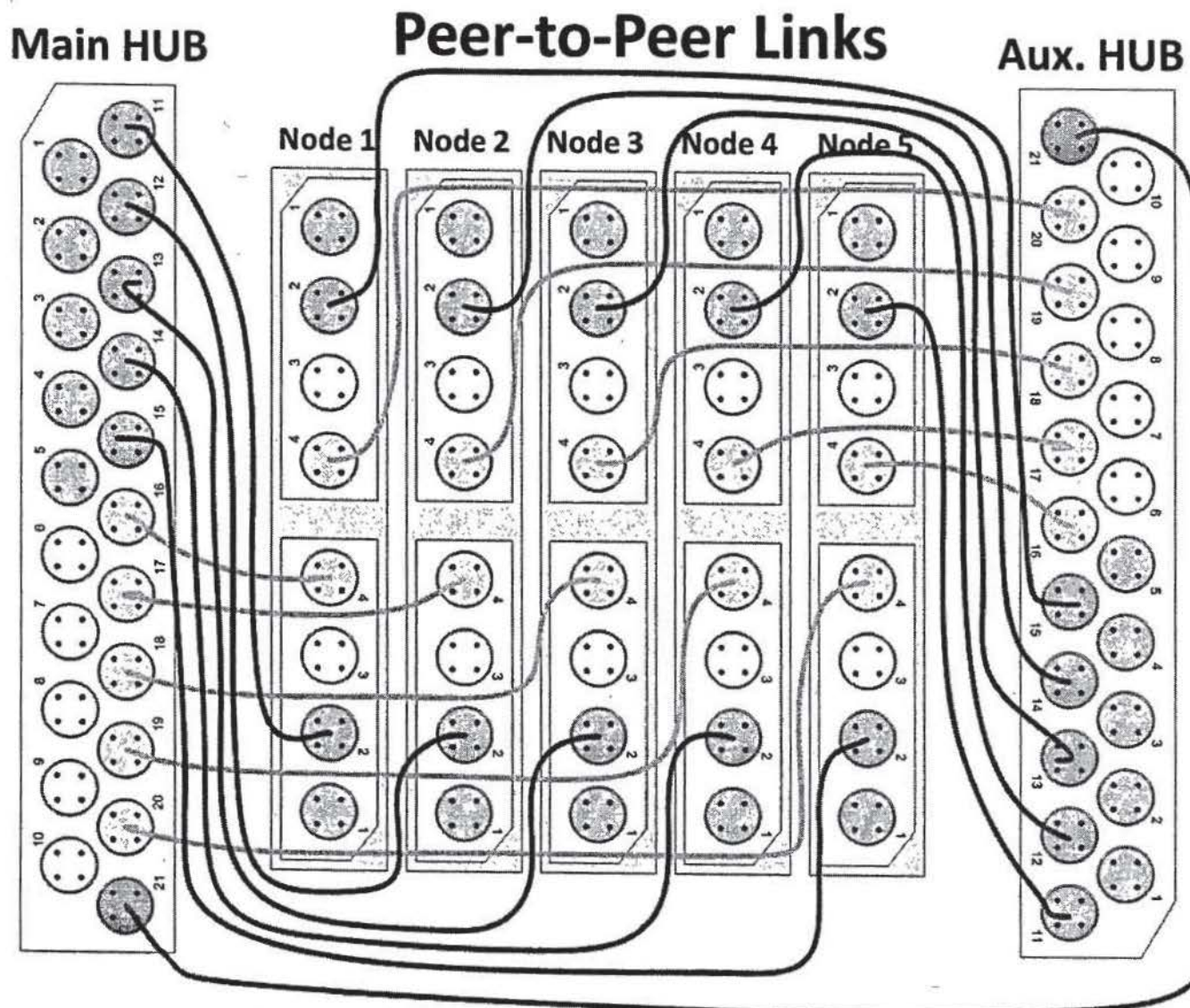
HUB Connectors are Same Orientation



Power and Clock Distribution Links are not Shown

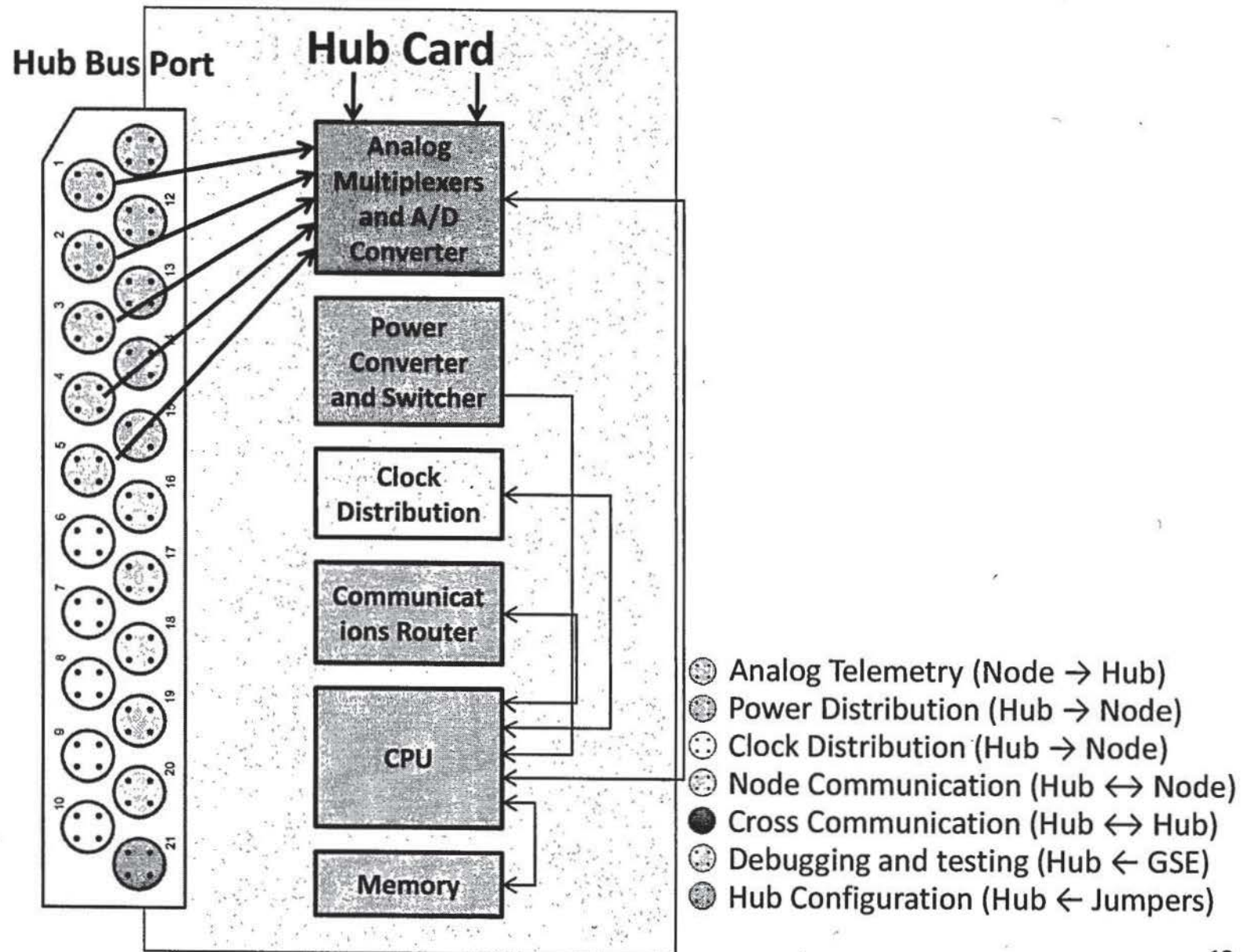
Suggested Bus Architecture #2

HUB Connectors are Reversed Orientation

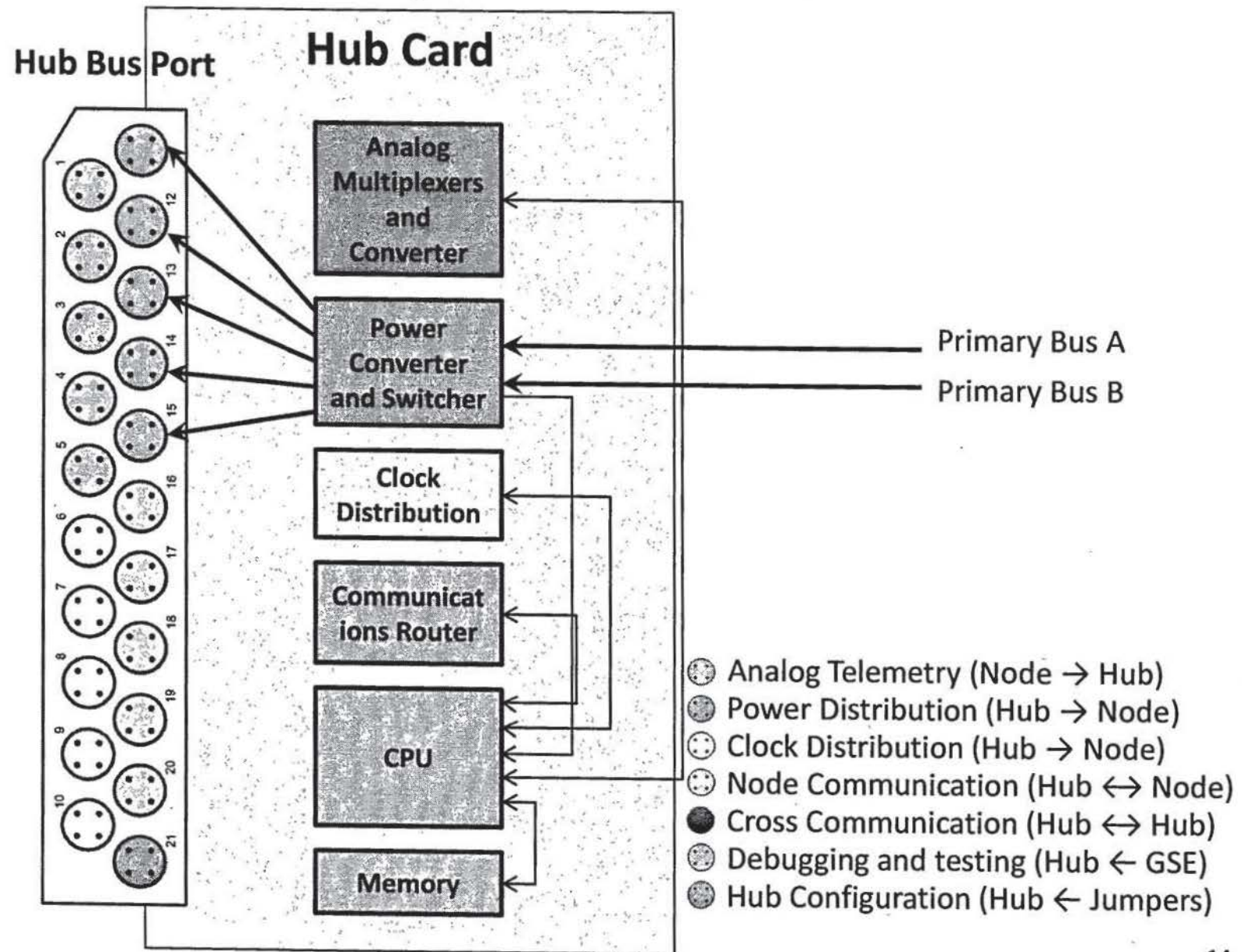


Analog and Clock Distribution Links are not Shown

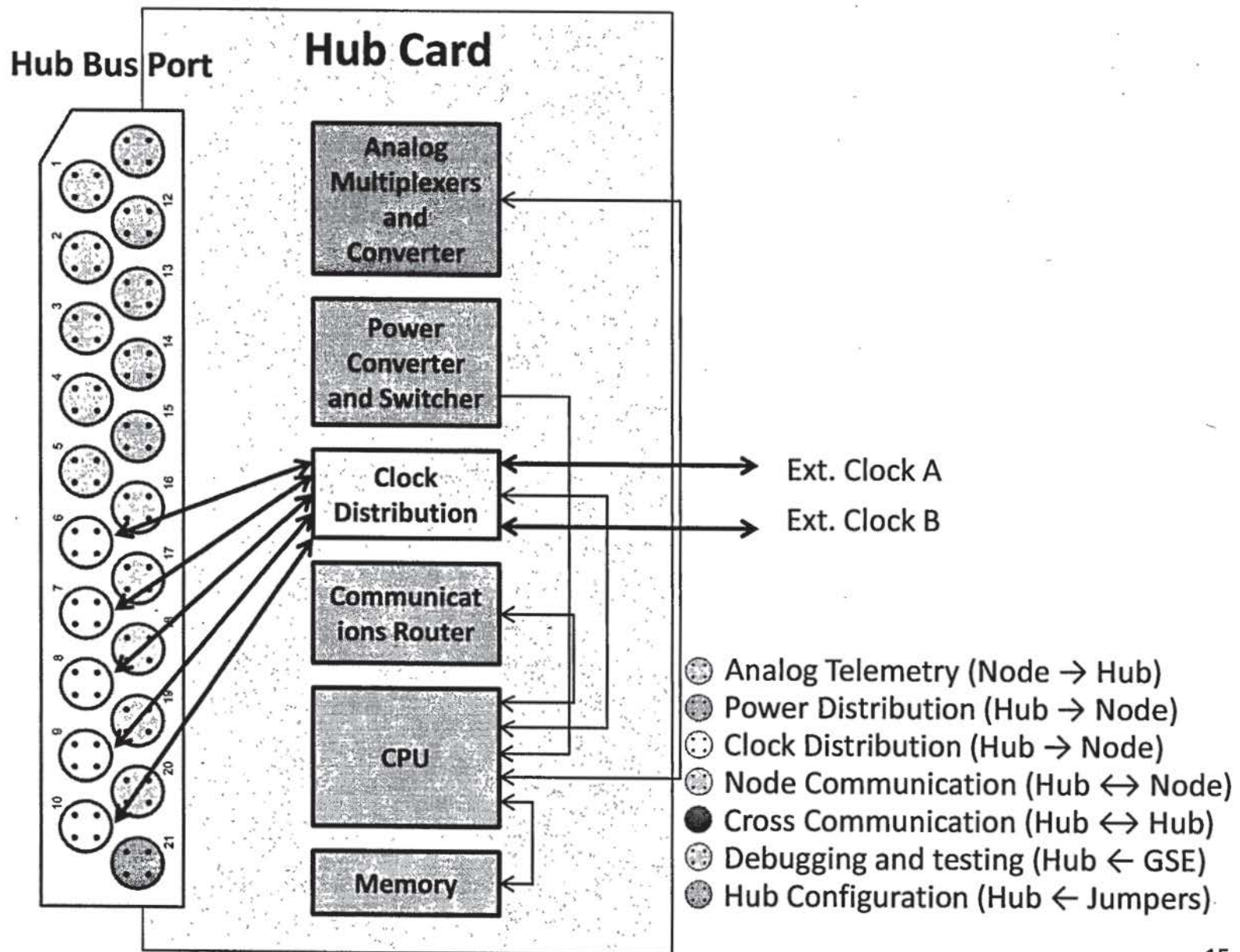
Hub Architecture: Analog Telemetry



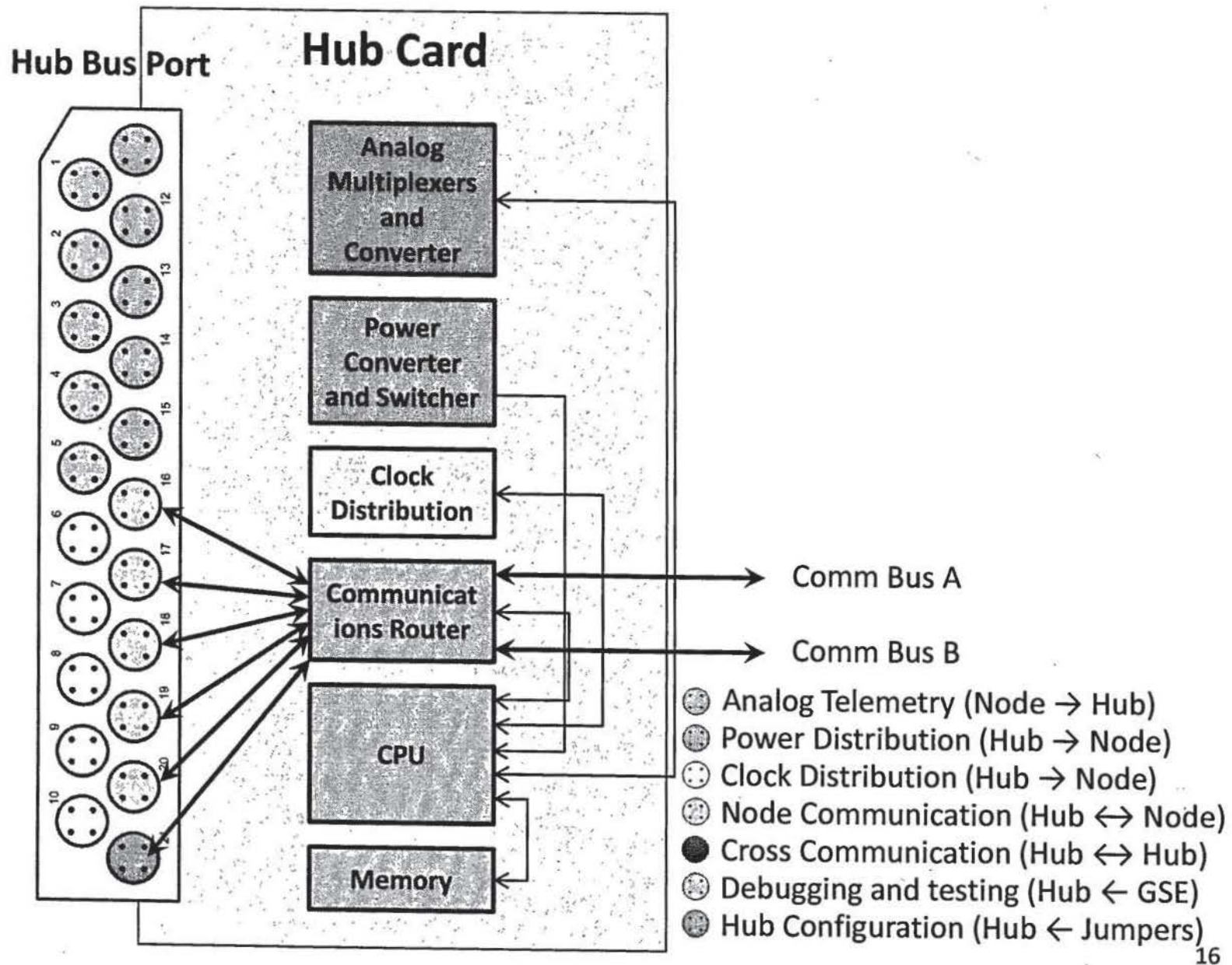
Hub Architecture: Power Distribution



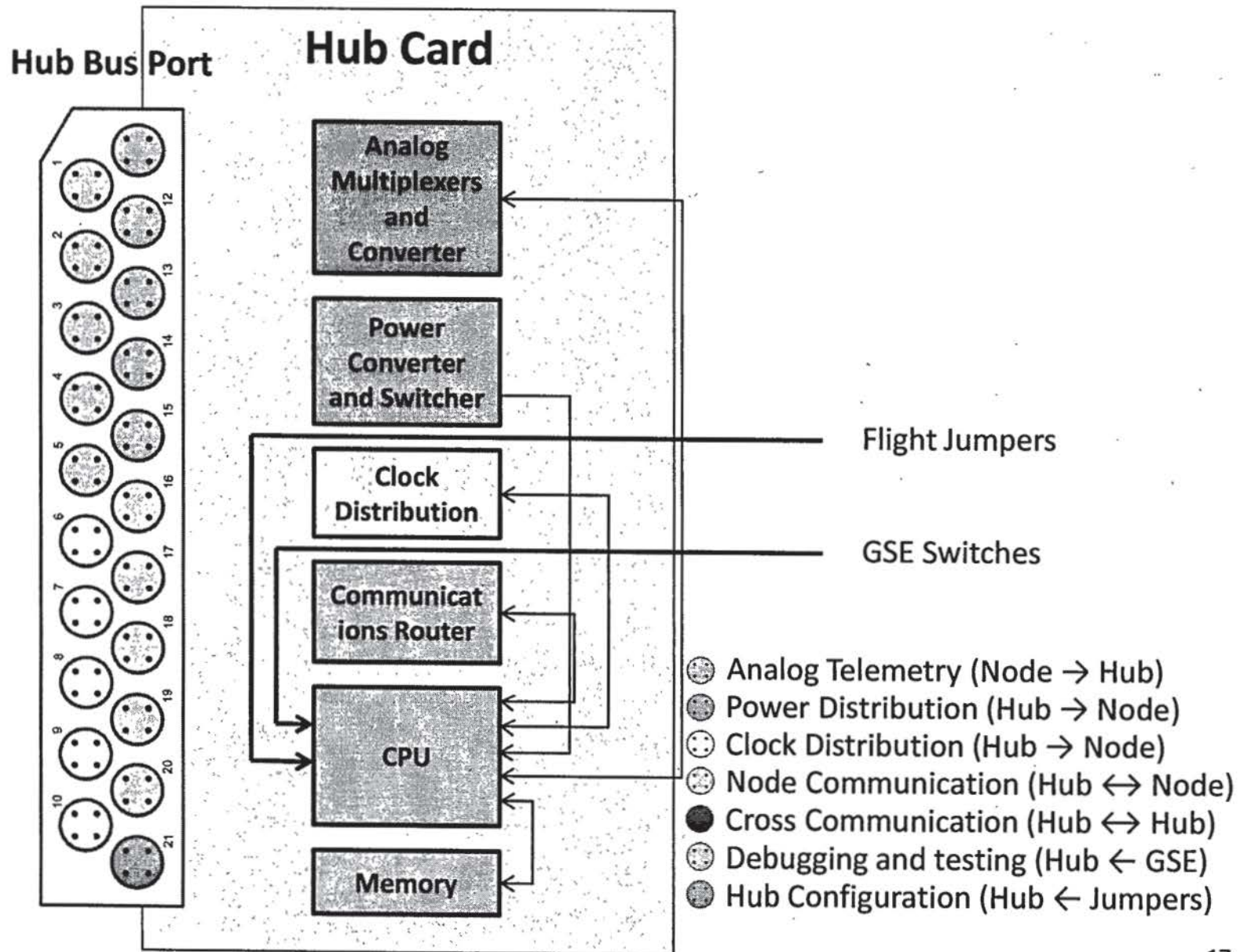
Hub Architecture: Clock Distribution



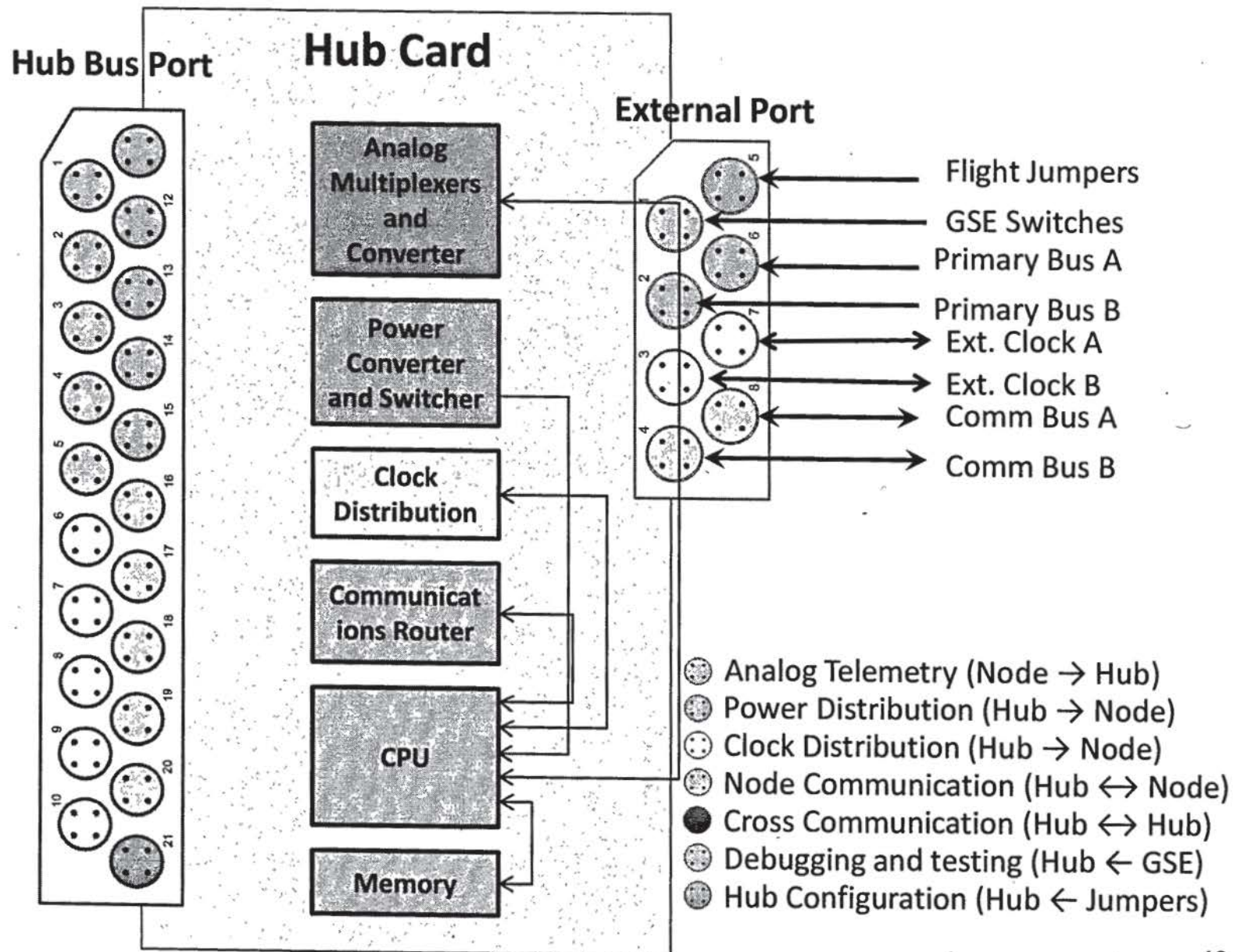
Hub Architecture: Communications Distribution



Hub Architecture: Test and Configuration



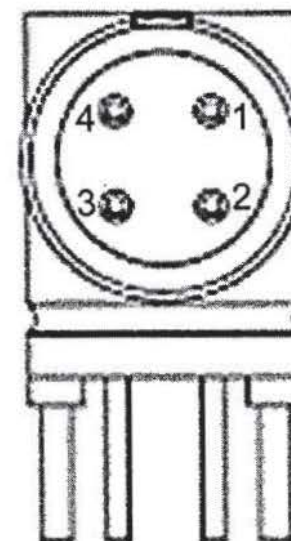
Hub Architecture: Proposed External Port



Connector Inserts Assignments

Group	Pin	Hub Bus Conn	Node Bus Conn	Hub Ext. Conn	Notes
Node Communication	1	TX+	RX+	TX+	Diagonal pins provide 100Ω impedance
	2	RX+	TX+	RX+	
	3	TX-	RX-	TX-	
	4	RX-	TX-	RX-	
Cross Communication	1	TX+	-	-	Diagonal pins provide 100Ω impedance
	2	RX+	-	-	
	3	TX-	-	-	
	4	RX-	-	-	
Sync Distribution	1	Clk_out+	Clk_in+	Clk_out+	Reset sync all Nodes; Ready tells Hub if Node is active or there is an error condition there
	2	Reset_out	Reset_in	Clk_in+	
	3	Clk_out-	Clk_in-	Clk_out-	
	4	Ready_in	Ready_out	Clk_in-	
Power Distribution	1	Switched Power (+15V)	Switched Power (+15V)	Prime +28V	1.5A after derating per each pin; total of up to 3A per insert
	2	Digital GND	Digital GND	Prime Return	
	3	Digital GND	Digital GND	Prime Return	
	4	Switched Power (+15V)	Switched Power (+15V)	Prime +28V	
Analog Telemetry	1	Analog_in	Analog_out	-	Thermistor is required for each Node; Analog signal is optional for Node. Sense tells Hub if Node is plugged
	2	Analog GND	Analog GND	-	
	3	Thermistor_in	Thermistor_out	-	
	4	Sense_in	Sense_out	-	
Debugging and Testing	1	-	-	Pushbutton Reset	Signals are used for Hub/System debugging only; active "low"
	2	-	-	Digital GND	
	3	-	-	EPROM Write Enable	
	4	-	-	Watchdog Disable	
Hub Configuration	1	-	-	Hub A/B Select	Short on Hub A/B selects between Prime and Auxiliary Hubs; Clock configuration selects which clock runs the Hub; internal or one of externals (for complete sync)
	2	-	-	Digital GND	
	3	-	-	Clock Configuration 1	
	4	-	-	Clock Configuration 2	

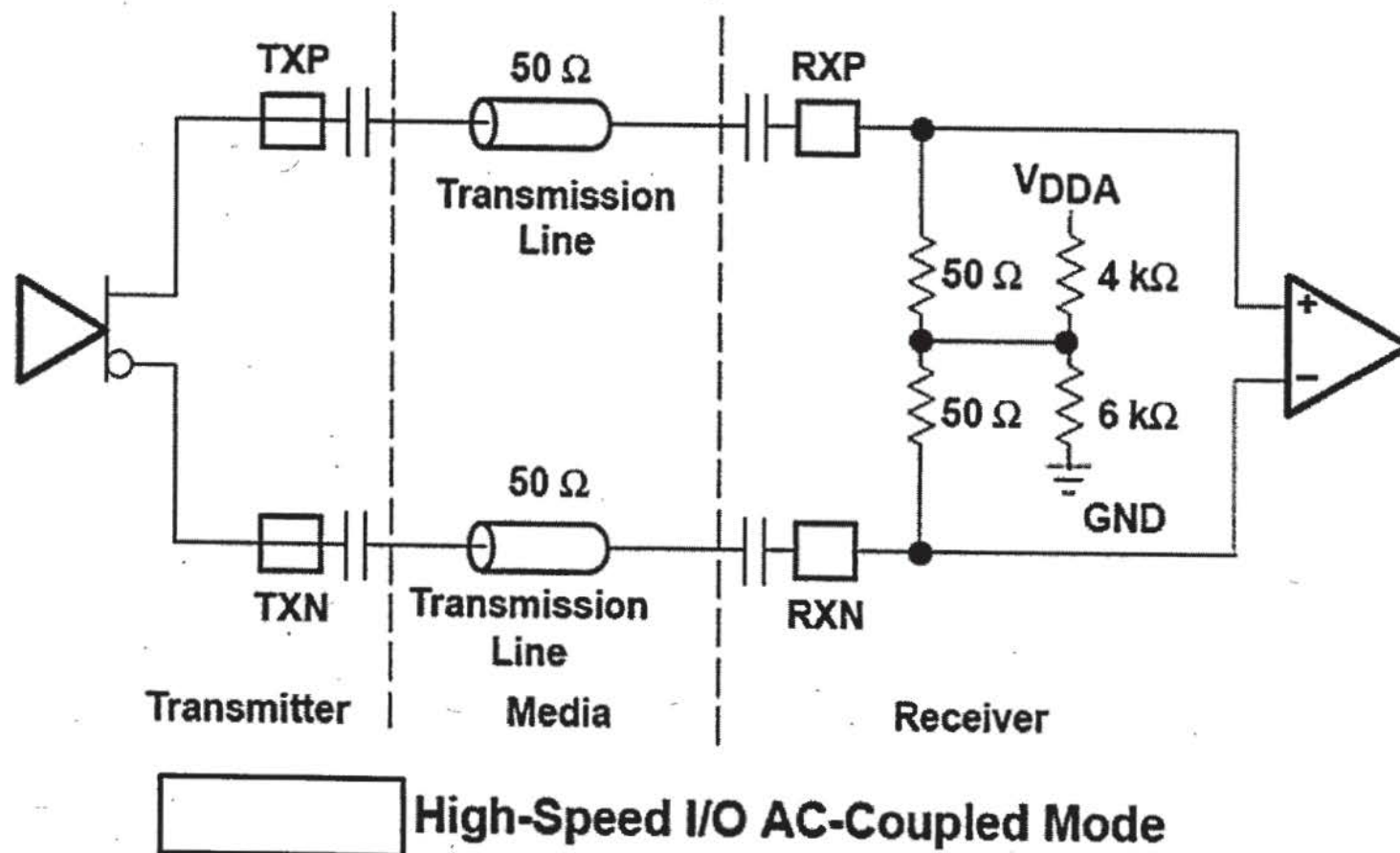
Shield on each QuadraX insert is for EMI/EMC only



Overall Comparison Chart

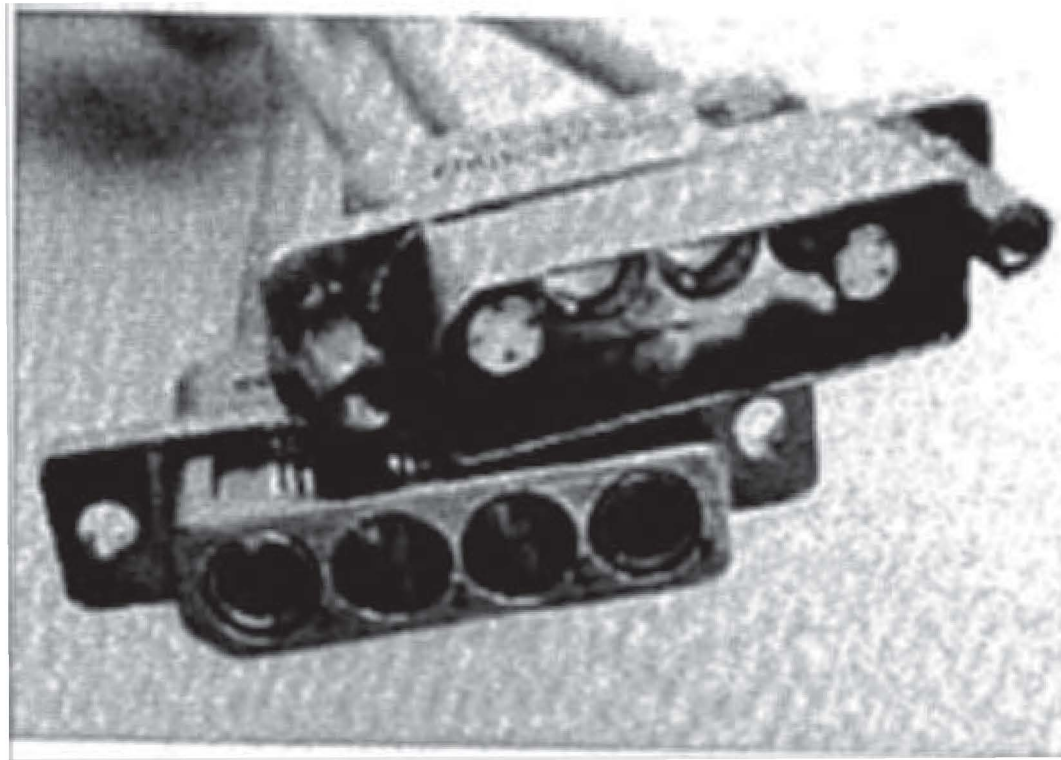
Function	Traditional	Suggested
Data Interface	Parallel	Serial
Data Exchange	Half-duplex	Full-duplex
Data Exchange Method	Synchronous	Asynchronous
Impedance Matching	Mis-matched	Matched
Bus Utilization	Single flow	Multiple flows
Redundancy	None	Full, Cross
Power Distribution	Multiple low voltages	Single 15V
Bus Current	High to very high	Low to very low
Common Mode Voltage	Low	High
Card Isolation	Complex	Simple
Hot Plugable	Not possible	Possible
Clock Distribution	System wide & matched	Events Sync
System Telemetry	Not Specified	Standardized
Telemetry Type	Not Specified	Digital and Analog
EM Interference	Leaking	Shielded
Outgassing	Possible	None
Connector Pins	Several hundreds	16 per Node + Case
Bus Interconnect	PCB	PCB or harness
Mechanical	3U or 6U	3U or 6U
Insertion Force	Medium	Low
Mating	Blind mate	Blind mate
Scoop proof	Yes	Yes
Inter-card Distance	20-25mm	up to 500mm

Communications Link Interconnection



Suggested Connector Family

Rugged D-Sub miniuature from Sabritec Inc.



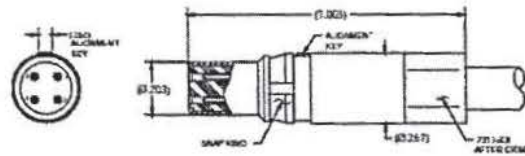
Connector Insert's Parameters

Quadrax insert

Electrical Specifications	
Dielectric Withstanding Voltage	250 VDC max
Insulation Resistance	5,000 Mega-Ohms min. @ 100 VDC
Contact Current Rating	3.0 Amps max.
Data Rates	>1 Gbits/sec
Differential Pair Cable Impedance	150 Ohm \pm 15 Ohm 100 Ohm \pm 10 Ohms
Signal to Shield Cable Impedance	75 Ohm \pm 10 Ohm 50 Ohm \pm 7 Ohms
Material & Finishes	
Shell & Inner Contacts	Brass per ASTM-B16, alloy UNS C36000 or BeCu per ASTM-B196, alloy UNS C17200, C17300 303 CRES per ASTM-A582 Gold plate per MIL-DTL-45204, Type II, Class 1
Insulators	PTFE per ASTM-D1710 or ULTERM 1000
Gasket/Seal	Silicone Rubber per A-A-59588

Inserts Types

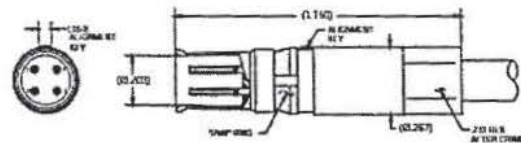
Size 9 Quadrax Pin Contact 100 Ohm



Part Number	Cable Type	Cable
019235-8000	Differential Quad	540-1183-000

For use in P/N: 012800-3002 thru 3006

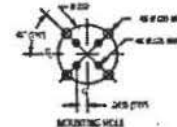
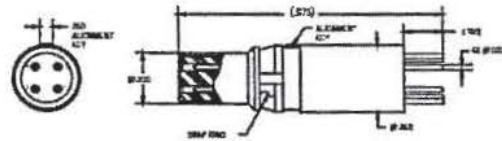
Size 9 Quadrax Socket Contact 100 Ohm



Part Number	Cable Type	Cable
019135-8000	Differential Quad	540-1183-000

For use in P/N: 012700-2002 thru 2006

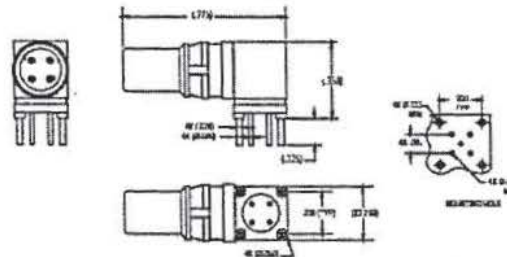
Size 9 Quadrax Pin Contact PCB Mount 100 Ohm



P/N: 019217-2006

For use in P/N: 012800-3002 thru 3006

Size 9 Right Angle PC Tail Quadrax Contact 100 Ohm



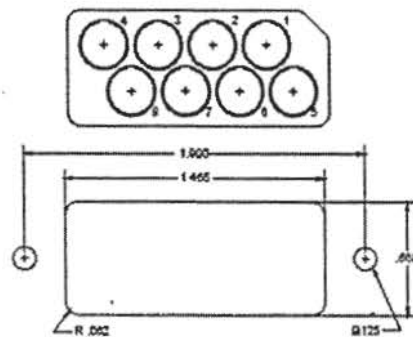
P/N: 019217-1001

For use in P/N: 012800-1000 thru 1001

Suggested Connector Configurations

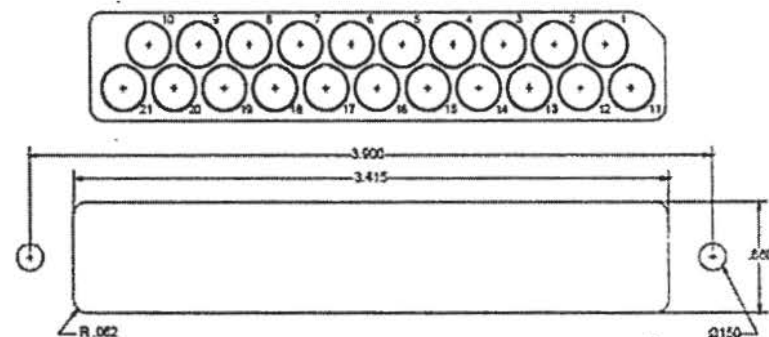
Node Card

Shell Size 3
Arrangement 3-8
8 # 9 Quad/Twinax Contacts



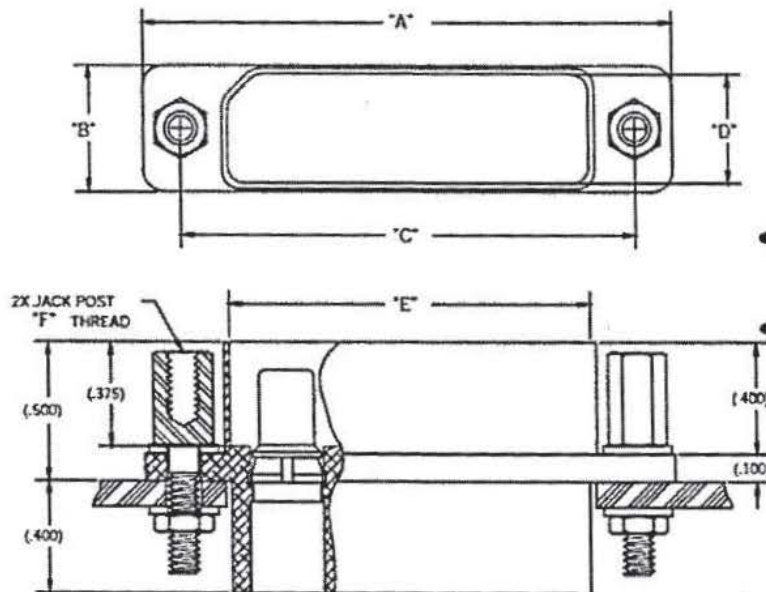
Hub Card

Shell Size 5
Arrangement 5-21
21 # 9 Quad/Twinax Contacts



Connector Dimensions

Quad/Twinax D-Sub Receptacle Cable Mount



Part Number	Contacts	A	B	C	D	E	F
012800-3002	2	1.325	.450	1.050	.390	.710	#2-56
012800-3003	4	1.925	.450	1.650	.390	1.310	#4-40
012800-3004	8	2.300	.750	1.900	.635	1.460	#4-40
012800-3005	16	3.600	.750	3.150	.635	2.660	#6-32
012800-3006	21	4.350	.750	3.900	.635	3.410	#6-32

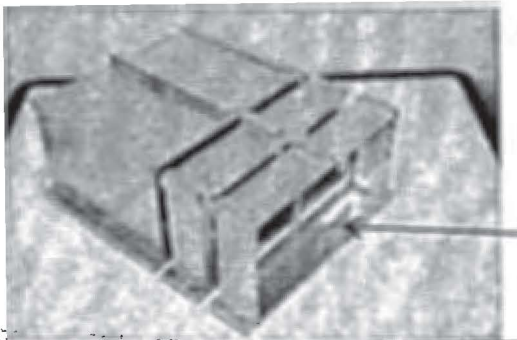
Node

Hub

Contacts are sold separately

Conclusion & Forward Work

- Signal list and connector selection presented here are intended to be a starting point for discussions and comments
- Electrical interface is the first priority for agreement
 - architectural approach
 - number of NODE cards in an assembly
 - connector type
 - style
 - signal list
 - pin assignment
- The mechanical concept is secondary but questions to address are:
 - Harness interconnect versus Printed Wiring Board (PWB)
 - Card frame versus single enclosure mechanical design



Card Frame

Please send comments to:
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