

ZTE A9611

Reverse engineering report

I. Tsvelykh, M. Shirokov, M. Wilhelm

- restricted -



1

General overview

2

Transceiver

3

Transmitter

4

Receiver

5

Bandpass filters

6

Antenna array

7

Power supply unit

› **Active/Passive Component Summary**

- **Total Weight:** 40 kg
- **Total Active/Passive Components:** 1,282 [1][2]
- **Total Active Components:** 880 [1]
- **Total Passive Components:** 402 [2]
- **Total Other Components:** 247 [3]
- **Total Components 1,529**

– [1] Excludes SOT discrete other components on modules

– [2] Excludes individual and module-based chip resistors/capacitors/inductors

– [3] Primarily DC/RF Cables & Connectors

Exhibit 2: ZTE A9611 S35 Specifications

Product	A9611 S35
Dimensions (H x W x D)	880 x 450 x 145 (mm)
Weight	40 kg
Frequency Band	3400-3600MHz 2500-2700MHz
OBW	100MHz
IBW	200MHz
Output Power	200W
Ingress Protection Rating	IP65
Working Temperature	- 40° to + 55° C
Relative Humidity	4% to 100% (non-condensation)
Carrier Configuration	Single Carrier 20/40/50/60/80/100MHz
Typical Power Consumption	980W
Heavy Power Consumption	1150W
Working Voltage	-48VDC
Ports on the BBU	eCPRI/CPRI port, data rate of 25.78125 Gbit/s or 100Gbit/s
Installation Mode	Pole mounted or wall mounted (on a pole) installation

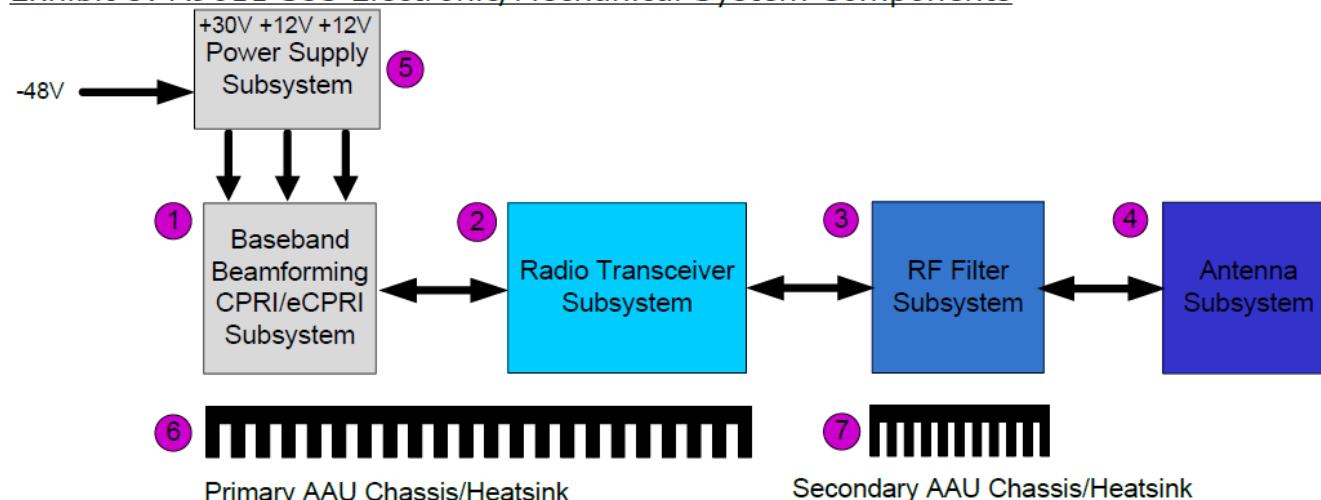
Source: ZTE Corporation

1. General overview

Mechanical and Electrical Subsystems

1. Baseband Processing Unit
2. 64T64R Radio Transceiver Unit (RU)
3. RF Filter Subsystem
4. Antenna Matrix Subsystem
5. Power Supply Subsystem
6. Primary AAU Radio Chassis/Heatsink
7. Secondary AAU Power Supply and RF Filter Chassis/Heatsink

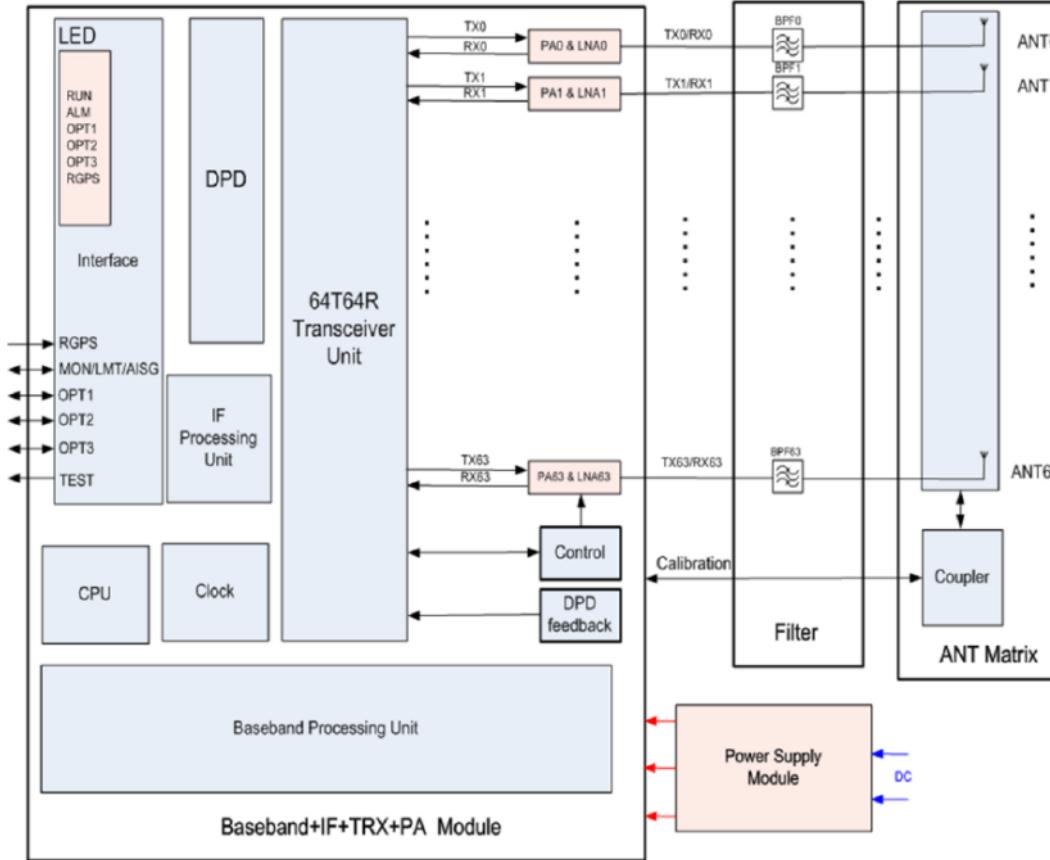
Exhibit 3: A9611 S35 Electronic/Mechanical System Components



Source: EJL Wireless Research LLC (September 2020)

1. General overview

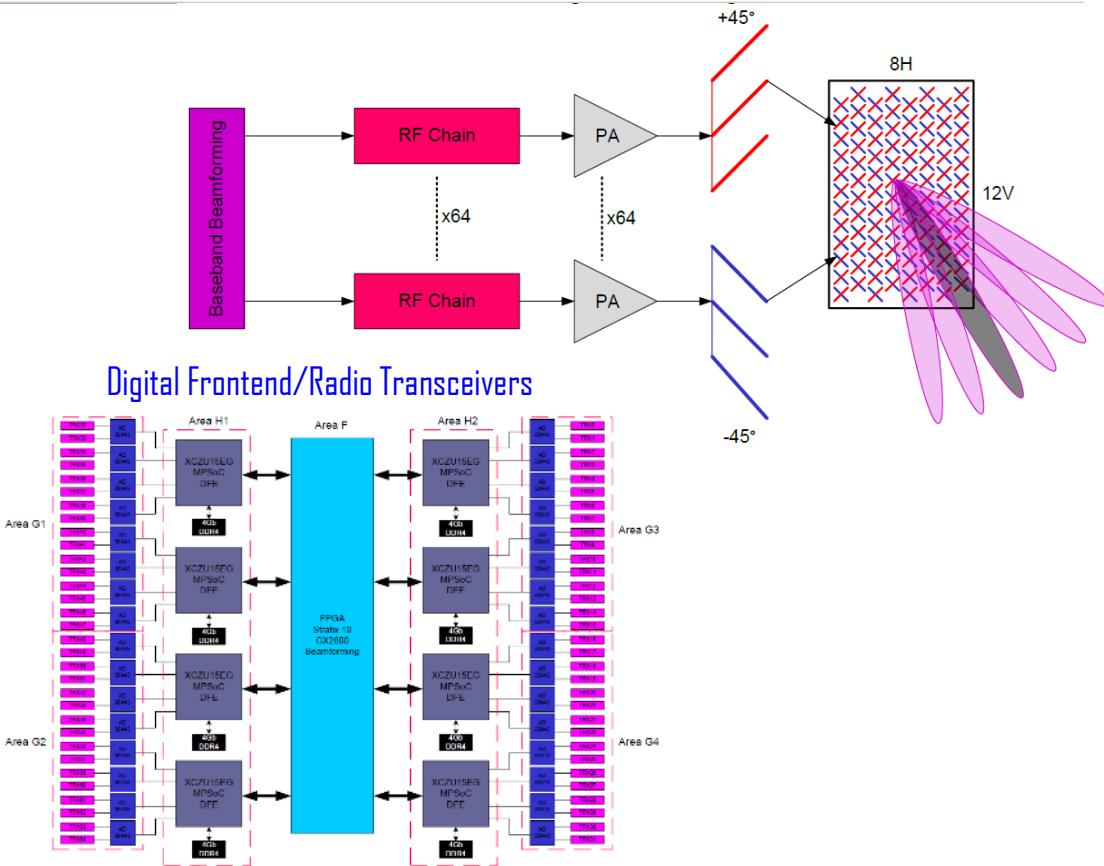
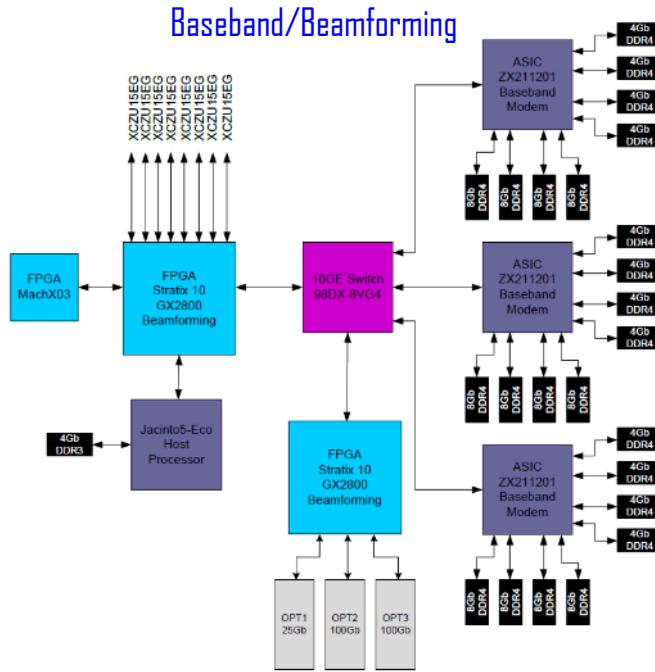
System Block Diagram



1. General overview

Beamforming Function

- › 1 radio channel excites 3 ANT elements
- › AAU: 64 radio channels map to 192 ANT elements (96 xpol antennas)



1. General

Mechanical design

Radome

Antennas and distribution board

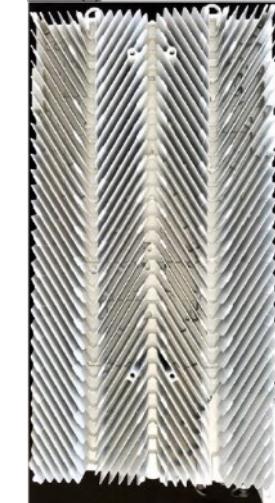
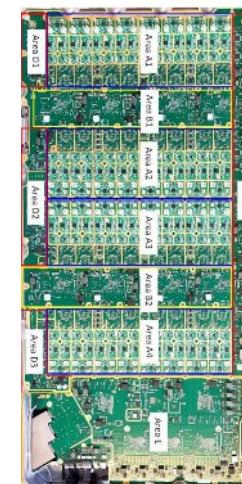
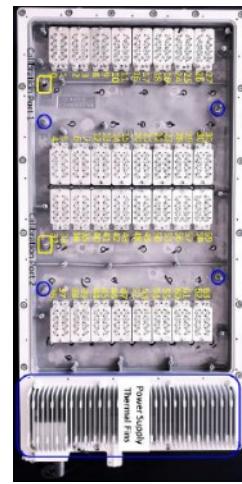
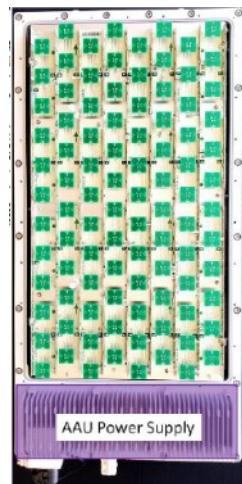
RF filters on a shield frame

Shield frame bottom view

Main board top view

Heatsink plate top view

Heatsink bottom view



flipped

flipped

1. General overview Heatsink Subsystem

Heatsink – primary and separate one for the PSU

1. Primary - cast Al >19kg
 2. V-shape thermal fins in back
 3. Thermal inserts with pedestals for trasceiver PCB and separately for ADC/DAC ICs
 4. Heat pipes in back of inserts
 5. Large thermal insert for L1 modem and beamforming section. Power ICs sit on smaller pedestals
 6. Main chassis dissipates 1kW through its heatsink
 7. 6 types of fins on each of 4 heat spreader panels

Heat spreader panels

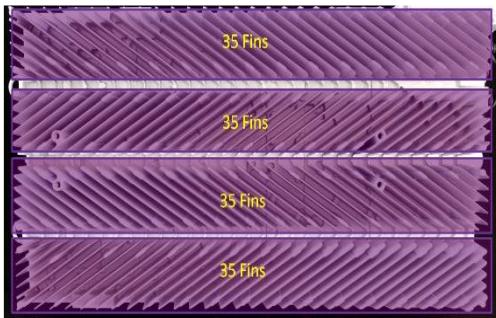


Exhibit 28: A9611 S35 Heat Transfer Fin Type

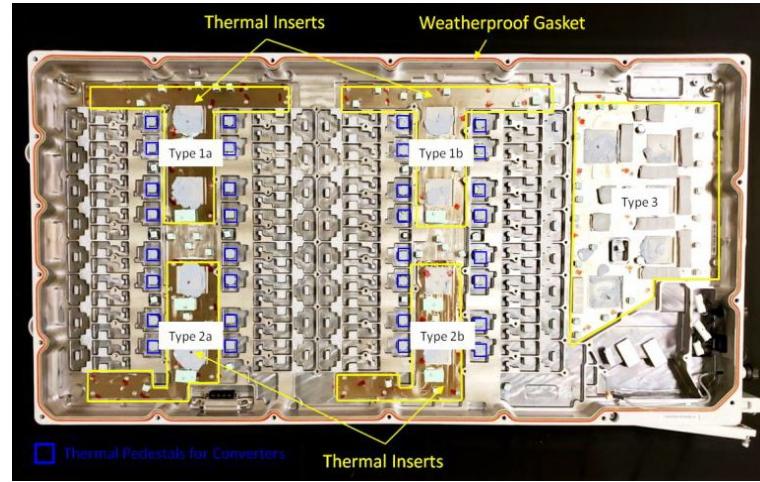
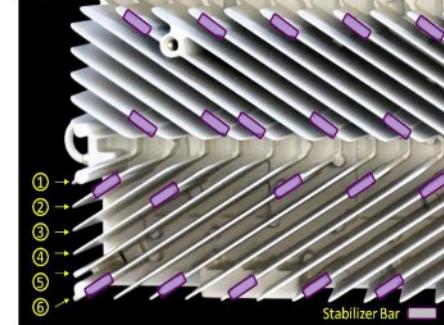


Exhibit 18: Type 1b Thermal Insert Detail, To

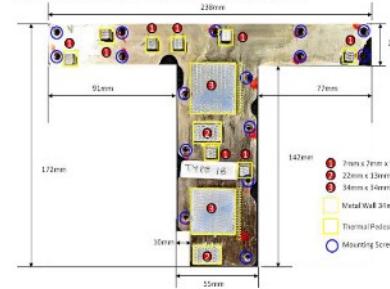
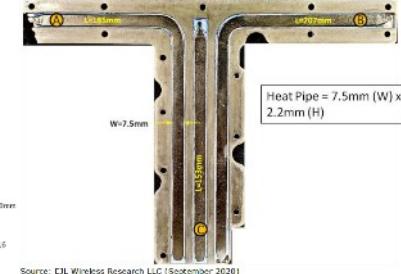


Exhibit 19: Type 1b Thermal Insert Detail, Bottom



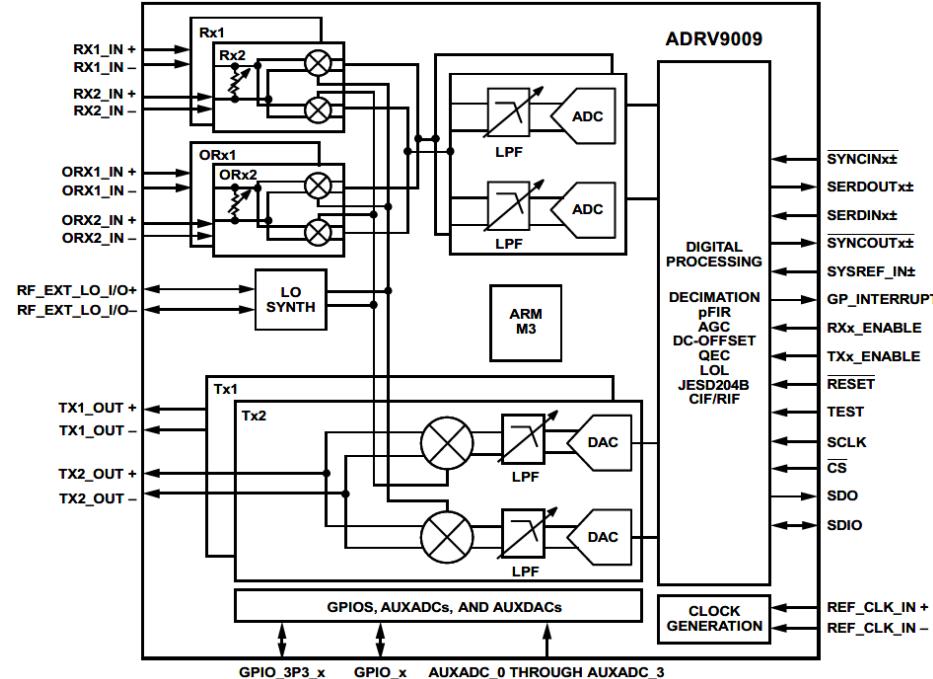
2. Transceiver

AD80443BBCZ (internal ADI number) overview

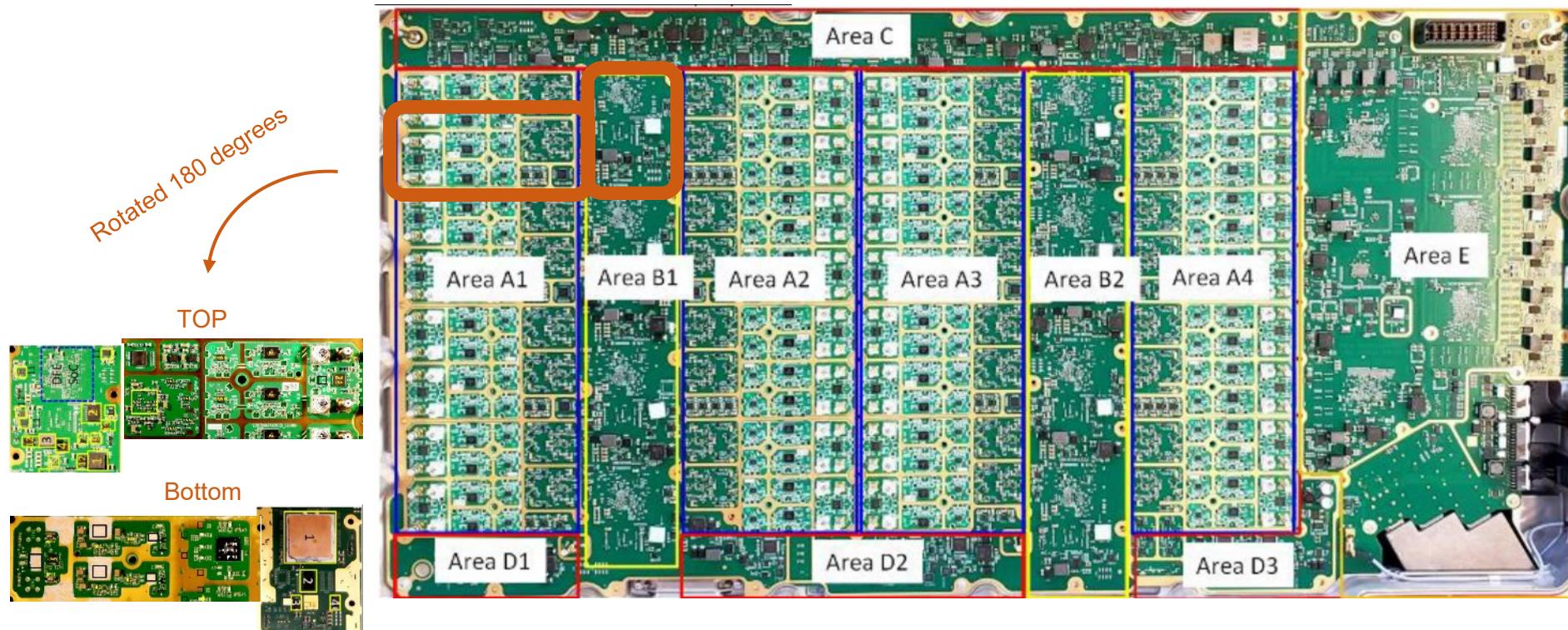


ADRV 9009 (most likely 80443)

- › Frequency Range
 - 75 - 6000MHz
- › Supply voltages:
 - Core 1.3V & 1.8V
 - 3.3V
- › TX
 - IBW 200MHz
 - 2 x differential TX outputs
- › RX
 - IBW 200MHz
 - 2 x differential RX inputs
- › FE Control
 - 19 x GPIOs 1.8V
 - 11 x GPIOs 3.3V

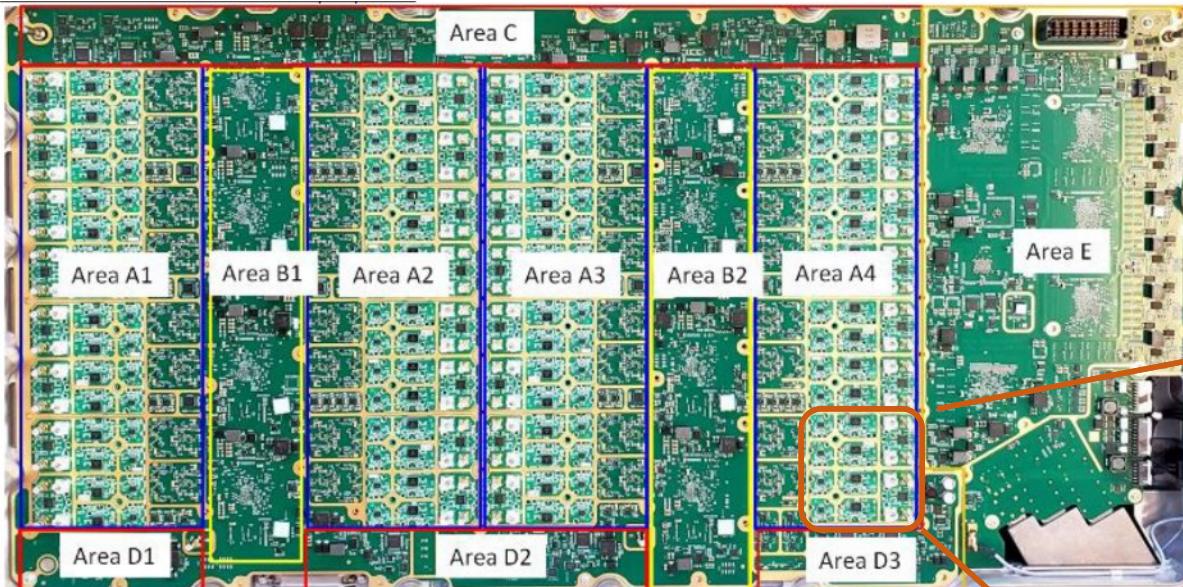


3. Transmitter TX lineup



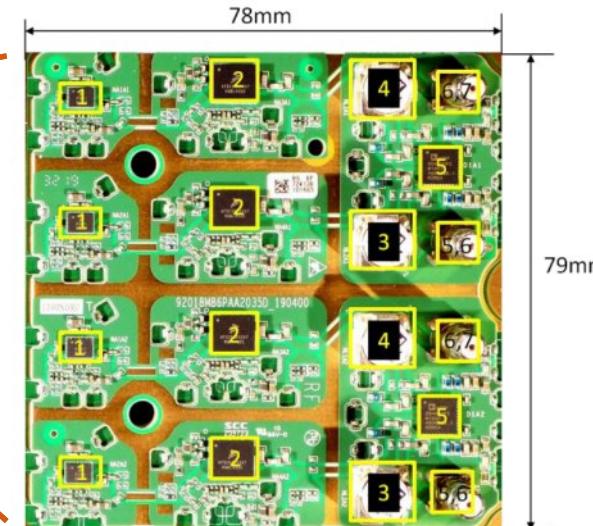
3. Transmitter

TX lineup, RF frontend modular PCB design

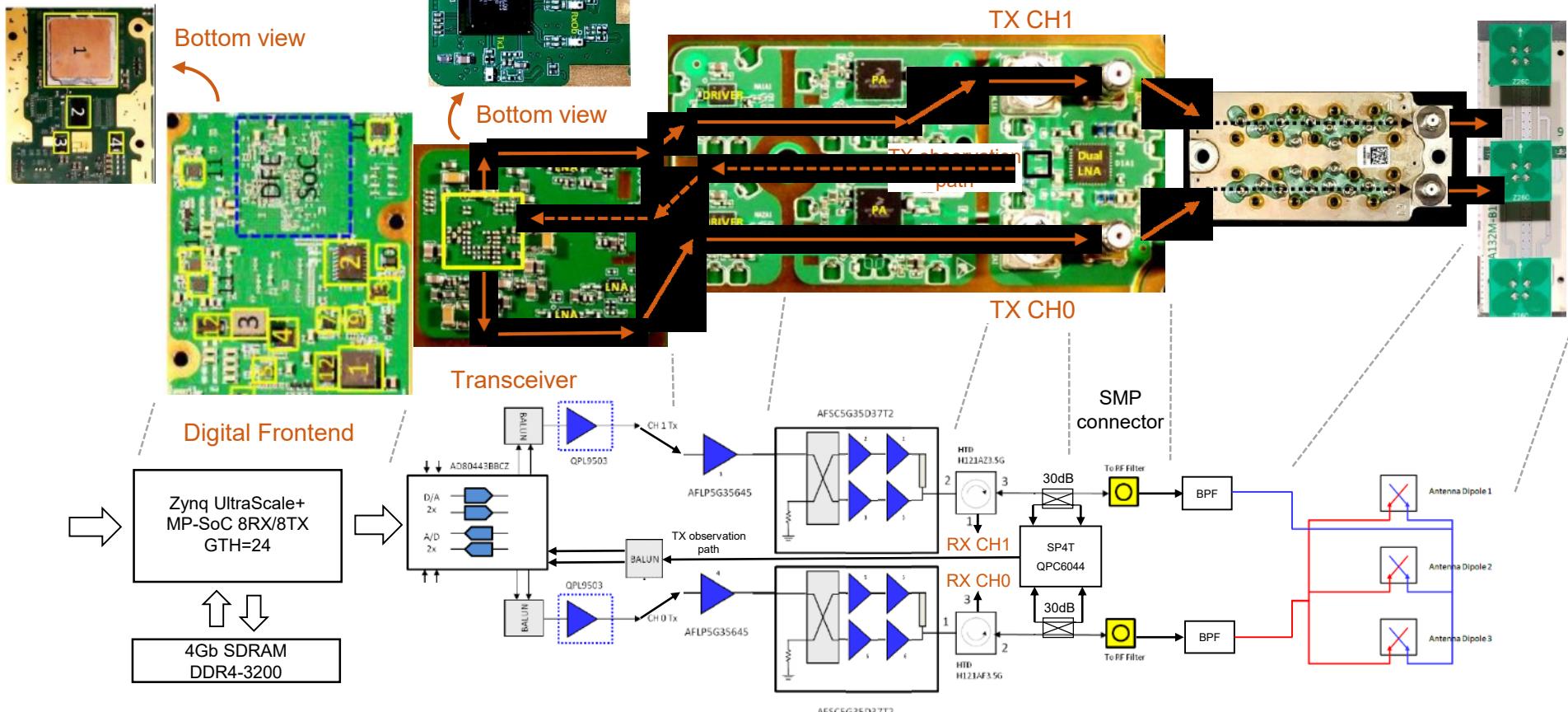


- › RF frontend board, filters and antennas define the frequency band, rest is frequency agnostic up to 6GHz
 - › Modular structure simplifies BOM list for various bands

- › 16 RF frontend PCBs mounted on a main board



3. Transmitter TX lineup



3. Transmitter

TX lineup, Pre-driver and PA module



Pre-driver

AFLP5G35645

3400–3800 MHz, 32 dB, 29 dBm
AIRFAST PRE-DRIVER MODULE



4 mm × 3 mm Module

Features

- Frequency: 3400–3800 MHz
- 3.3 V or 5 V supply for RF amplifier
- P1dB: 25 dBm @ 3600 MHz, $V_{CC2} = 3.3$ Vdc
- P1dB: 29 dBm @ 3600 MHz, $V_{CC2} = 5$ Vdc
- Power consumption:
 - 114 mW @ $V_{CC2} = 3.3$ Vdc
 - 168 mW @ $V_{CC2} = 5$ Vdc
- Fully matched (50 ohm input/output, DC blocked)
- Compact 4 mm × 3 mm LGA package

AFSC5G35D37

Dual driver Doherty PA module

AFSC5G35D37

3400–3600 MHz, 29 dB, 5 W Avg.
AIRFAST POWER AMPLIFIER
MODULE



10 mm × 6 mm Module

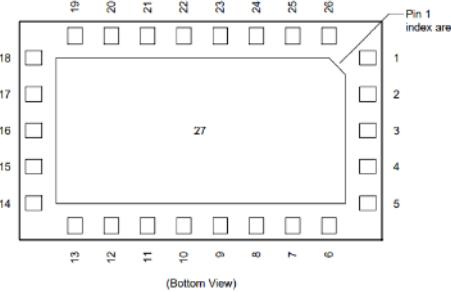
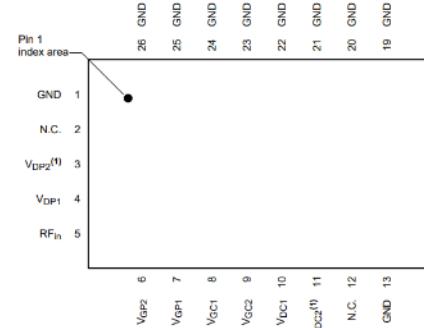
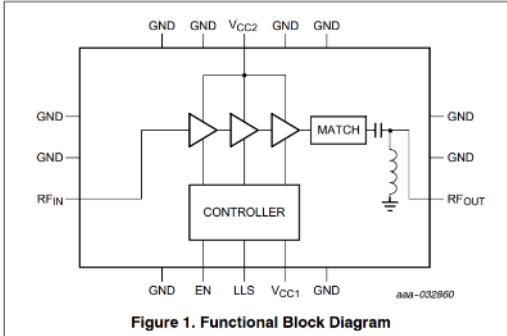
Features

- Frequency: 3400–3600 MHz
- Advanced high performance in-package Doherty
- Fully matched (50 ohm input/output, DC blocked)
- Designed for low complexity analog or digital linearization systems

Typical LTE Performance: $P_{out} = 5$ W Avg., $V_{DD} = 30$ Vdc, 1 × 20 MHz LTE, Input Signal PAR = 8 dB @ 0.01% Probability on CCDF.⁽¹⁾

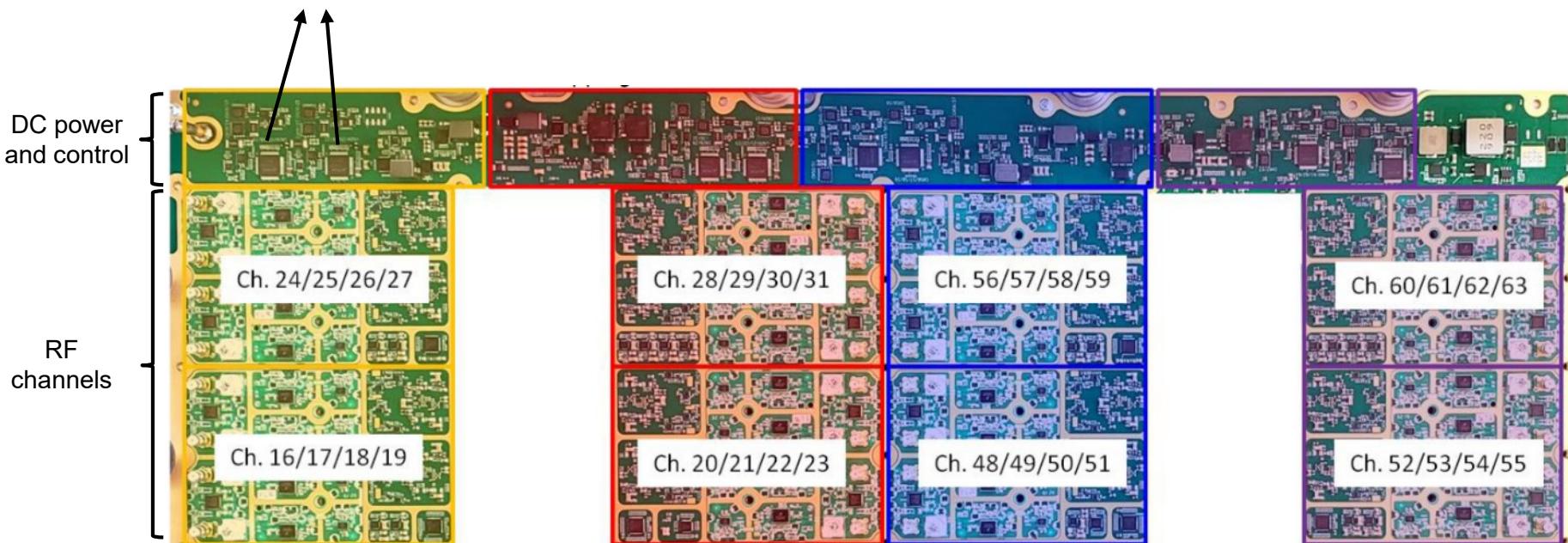
Carrier Center Frequency	Gain (dB)	ACPR (dBc)	PAE (%)
3400 MHz	29.2	-31.4	38.8
3500 MHz	29.3	-32.8	39.2
3600 MHz	29.4	-31.0	38.6

1. All data measured with device soldered in NXP reference circuit.



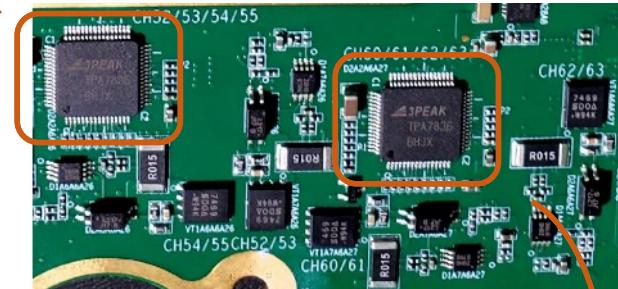
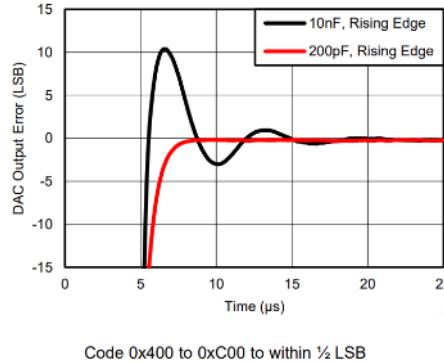
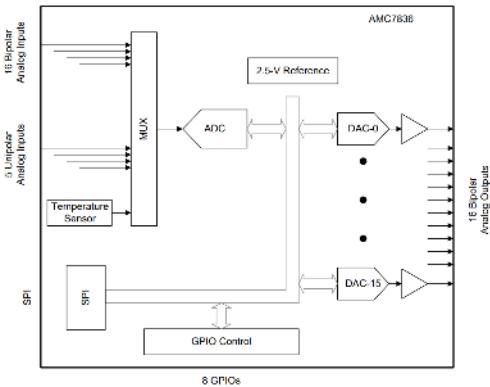
3. Transmitter Bias & Control

› 2x TPA7836 Bias&Control ICs per 8x RF channels

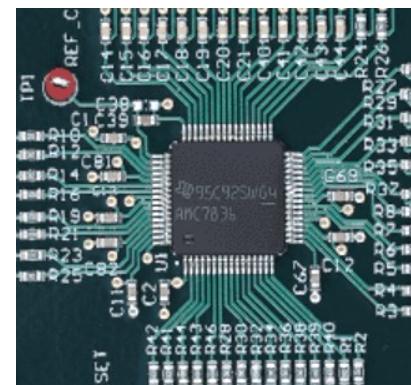


3. Transmitter Bias & Control

- TPA7836 by 3PEAK is presumably a copy of TI's AMC7836:
 - similar code, same pin count, compatible channel count

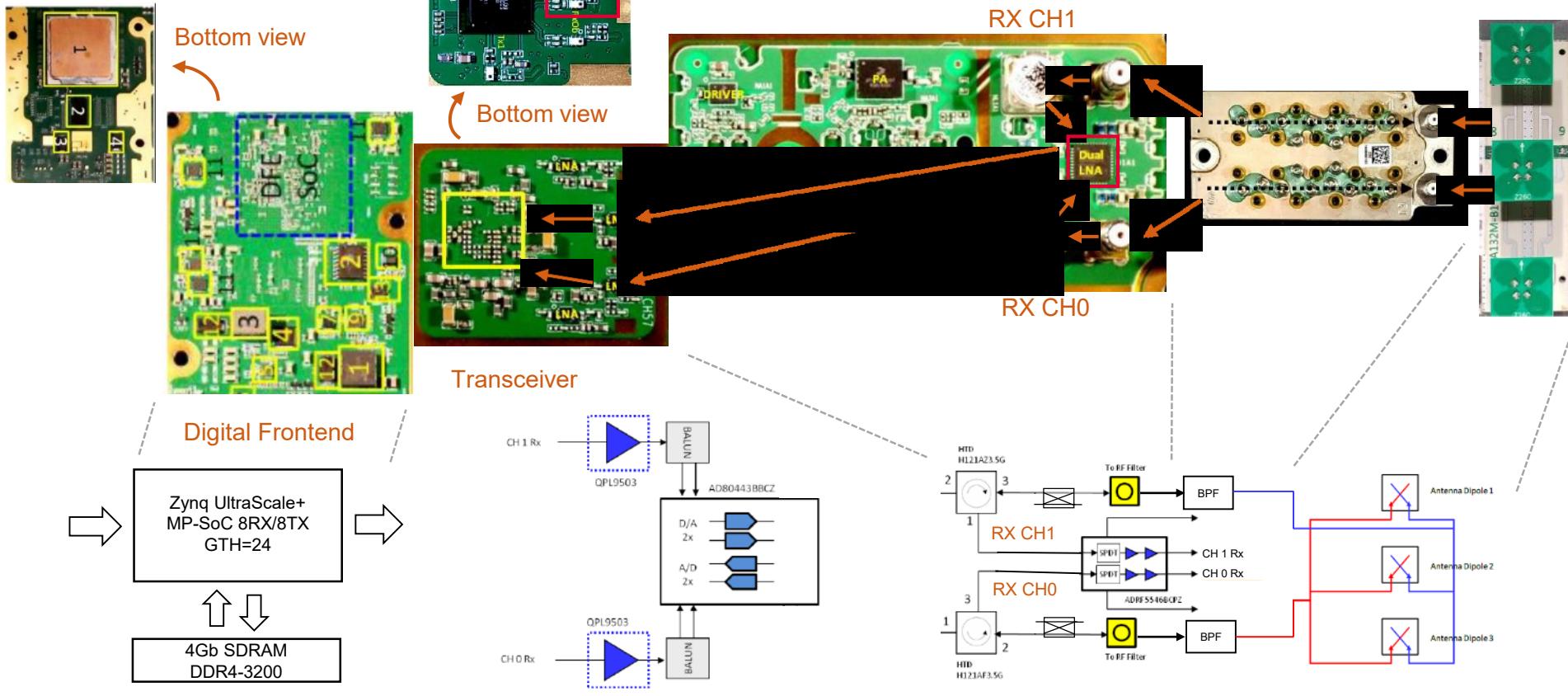


3PEAK TPA7836



- AMC7836 is not capable of fast switching (<<1us), it's 5us and longer
- There are no external switches around PAs or B&C
- TX apparently is not capable of <1us switching

4. Receiver RX lineup

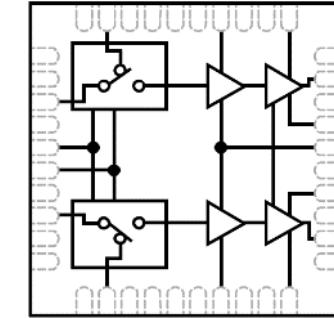


4. Receiver

RX FE components

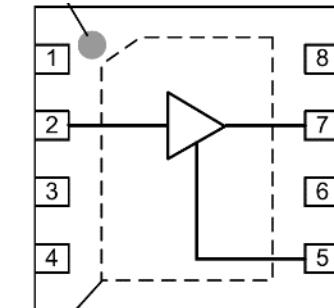
2 Chan RXA AFE ADRF5546PCBZ (data from ADRF5545)

- › *Supply voltage:*
 - 5V
- › *Frequency Range*
 - 2.4 – 4.2GHz
- › *Gain*
 - 32dB (high gain)
 - 16dB (bypass)
- › *NF*
 - 1.45dB (high gain & bypass)
- › *Power handling*
 - 40dBm
- › *OIP3*
 - 32dBm (high gain)
 - 29dBm (bypass)



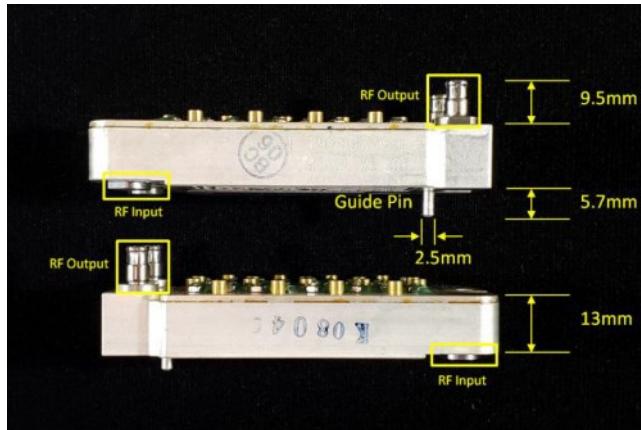
LNA QPL9503

- › *Supply voltage:*
 - 3.3 - 5V
- › *Frequency Range*
 - 600 - 6000MHz
- › *Gain*
 - 21.6dB
 - Power down mode
- › *NF*
 - 0.9dB
- › *OIP3*
 - 35.5dBm

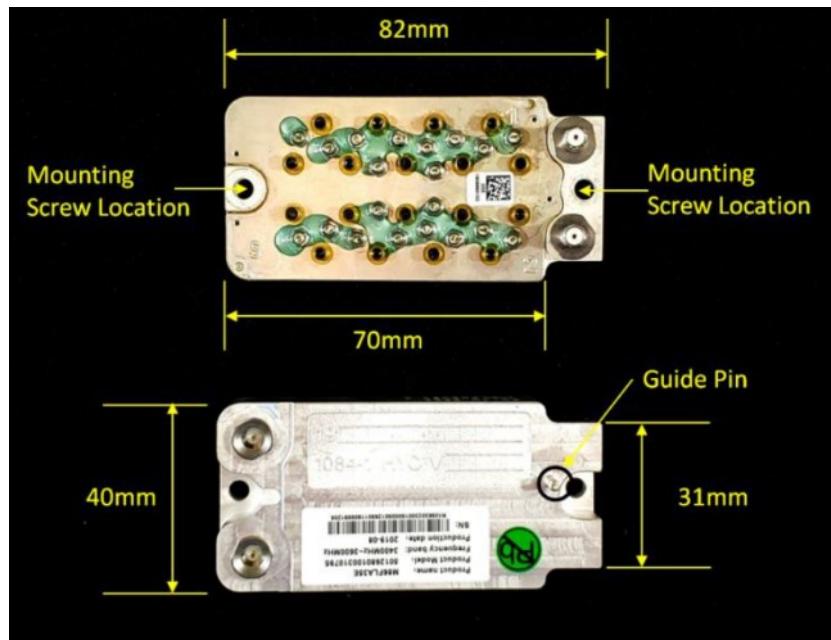


5. Bandpass filters

- › Band definition filter supplier (presumably):
Shenzhen Xinlianbo Communication TechnologyCo. Ltd.,
also known as
KINGWAVE Communication Technology Co. Ltd.
- › 9 cavity resonator design
- › 3400 – 3600 MHz



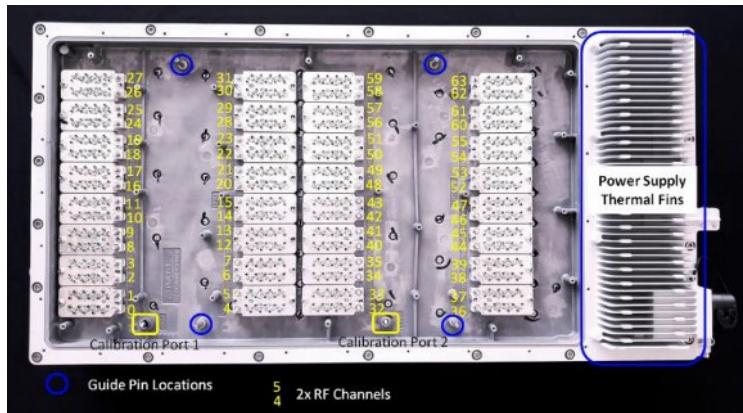
Product name:	M86FLA35E
Product Model:	5012680100310795
Frequency band:	3400MHz-3600MHz
Production date:	2019-08
SN:	R106630230015000501268011908891206



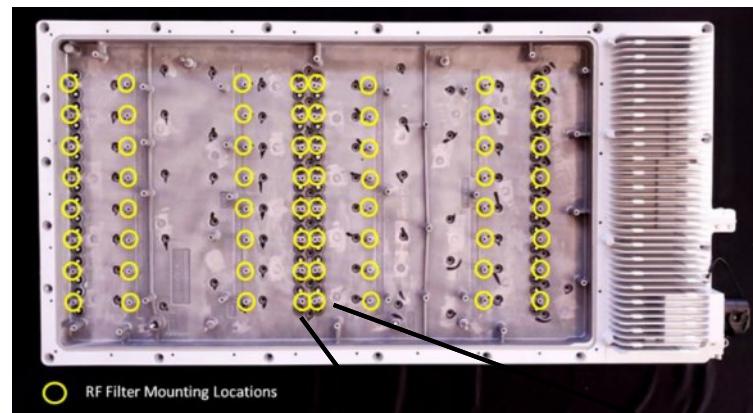
5. Bandpass filters

RF filter frame

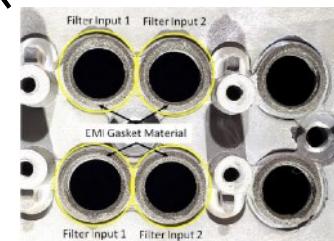
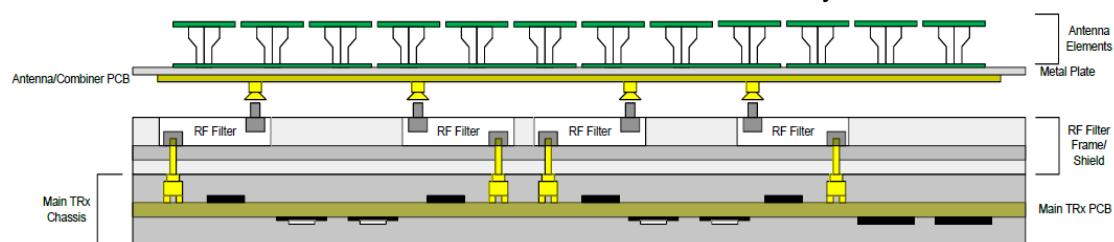
Top view, with mounted filters



Top view, filters removed



Cross section of entire PCB assembly

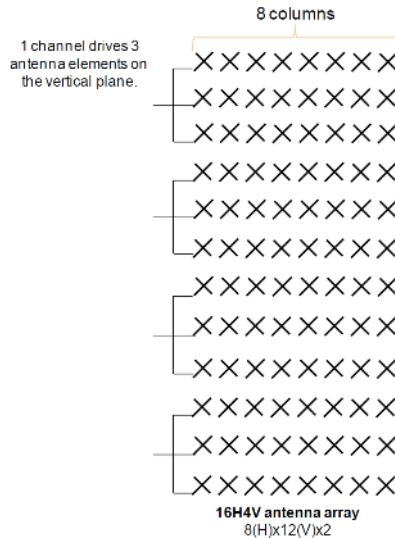


Gaskets for SMP connectors

6. Antenna array

Array Architecture	16H4V
Antenna Array	8(H) x 12(V) x 2
Polarization	+45° and -45°
Gain	10.5/11 dBi
Horizontal Beamwidth	100/90 ±10°
Electrical Tilt	3°

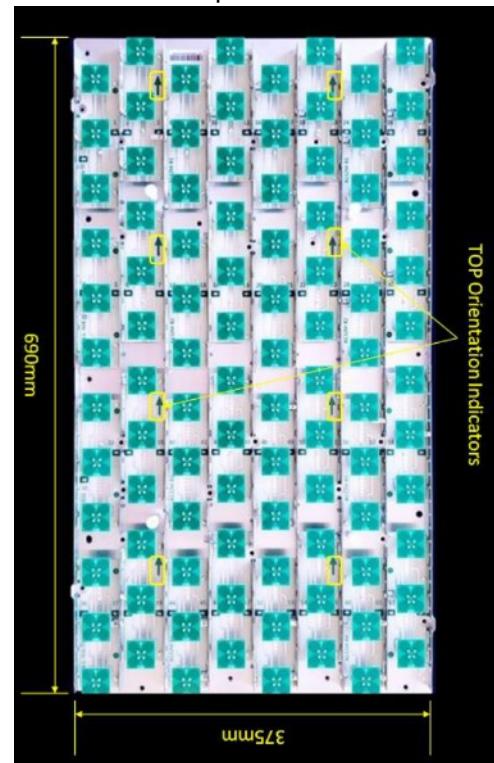
Source: ZTE Corporation



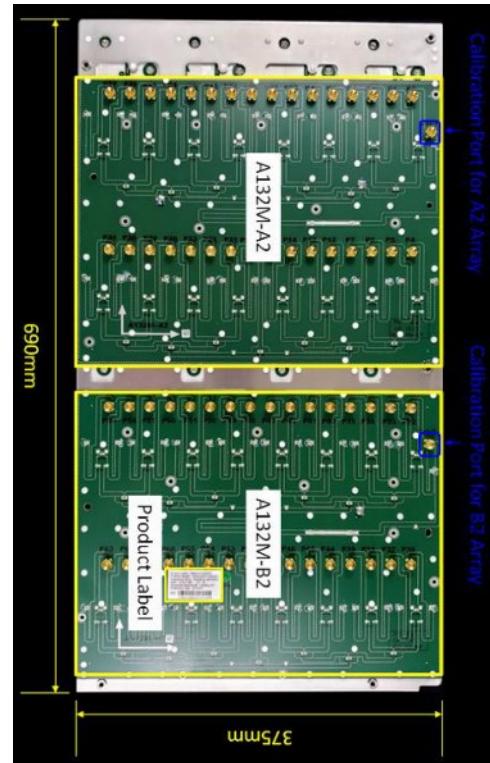
1 channel drives 3 antenna elements on the vertical plane. 1 channel drives 1 antenna element on the horizontal plane.

Antenna array frame

Top view



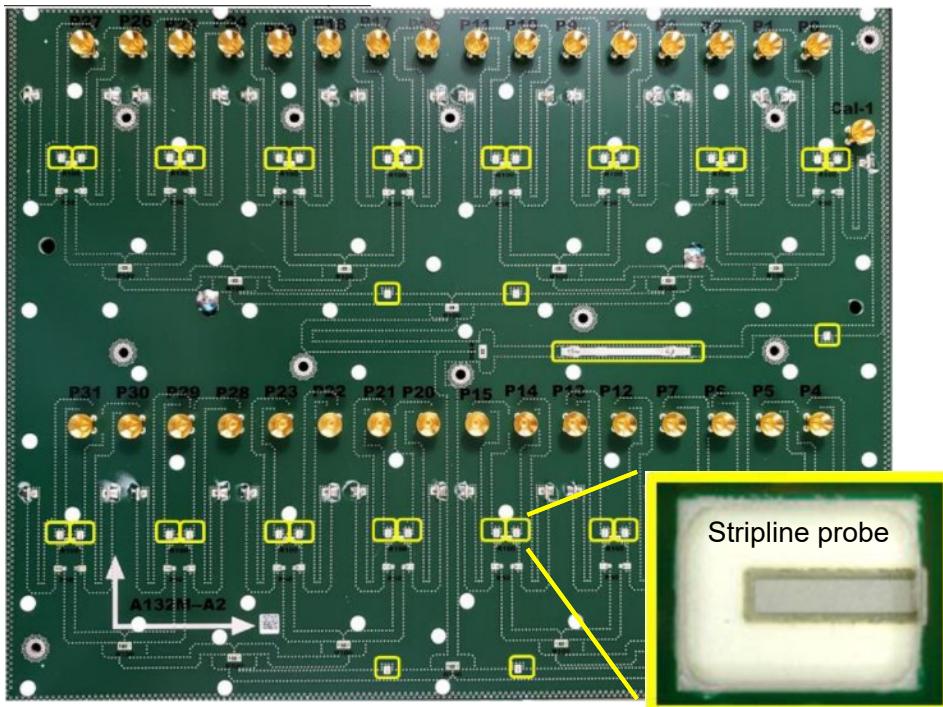
Bottom view



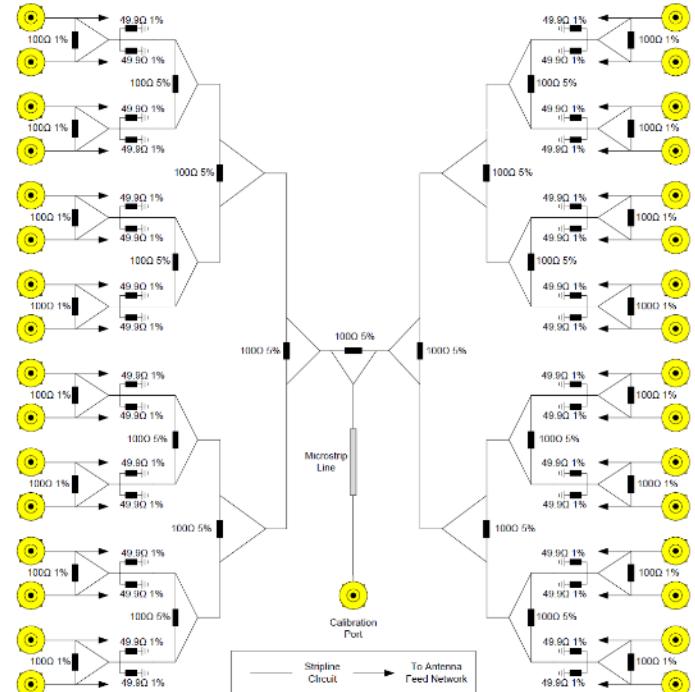
6. Antenna array

Stripline Distribution/Combiner Network PCB for antenna measurement / calibration

PCB view

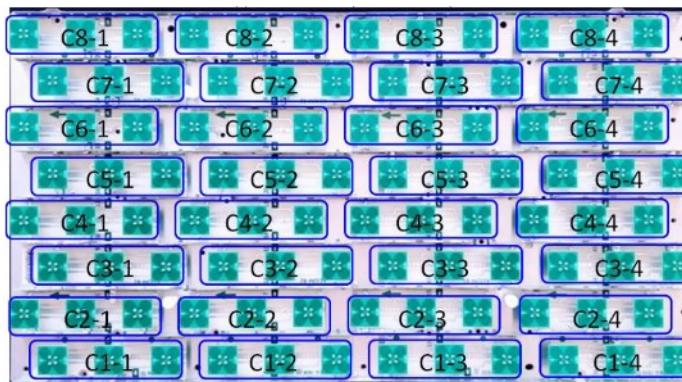


Alleged schematic

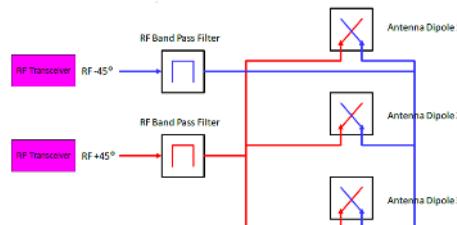


6. Antenna array

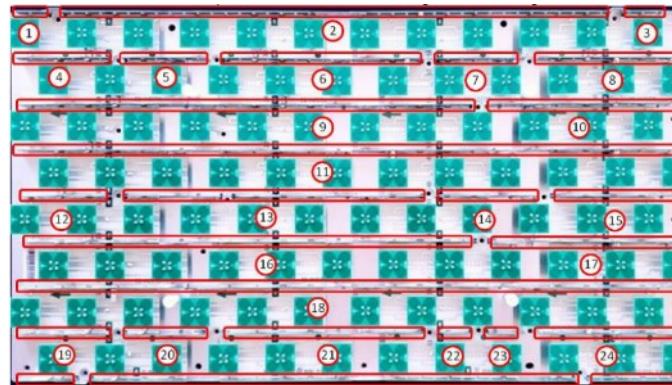
Array elements per channel grouping



3 dual polarization elements per 2 RF channels



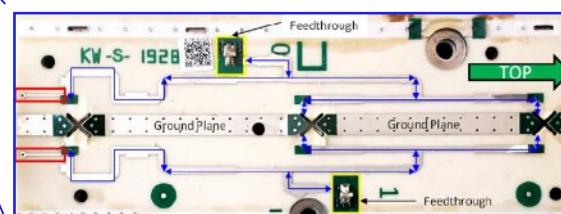
Column GND vertical isolation bars



GND bar side view



1:3 splitter/combiner with element attachment slots



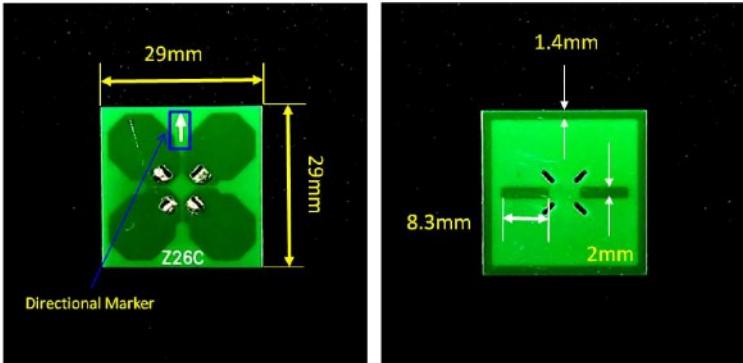
Individual element side view



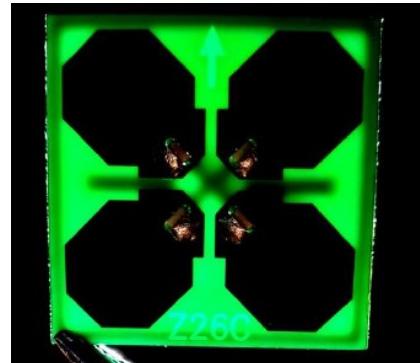
6. Antenna array

Individual element design

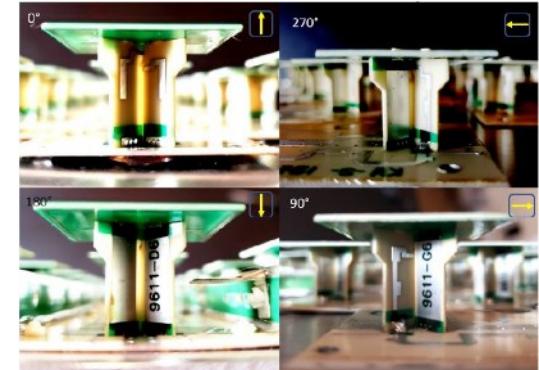
Individual antenna element top plate view



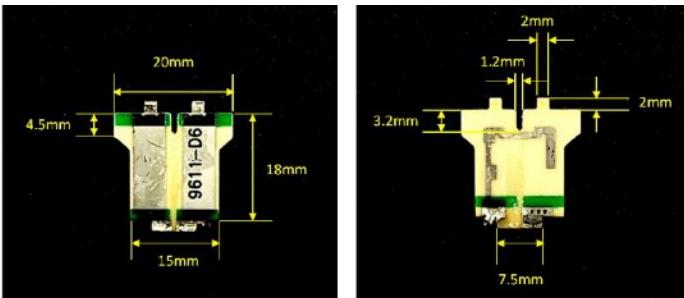
Assembly see-through



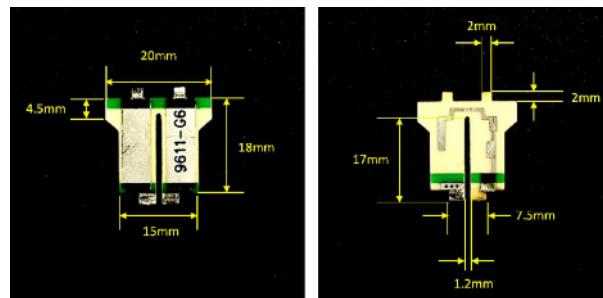
Assembly side views



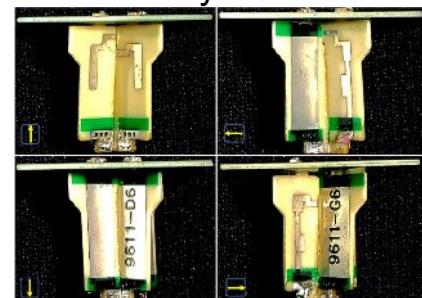
Vertical feed board 1



Vertical feed board 2



Vertical feed boards assembly side view



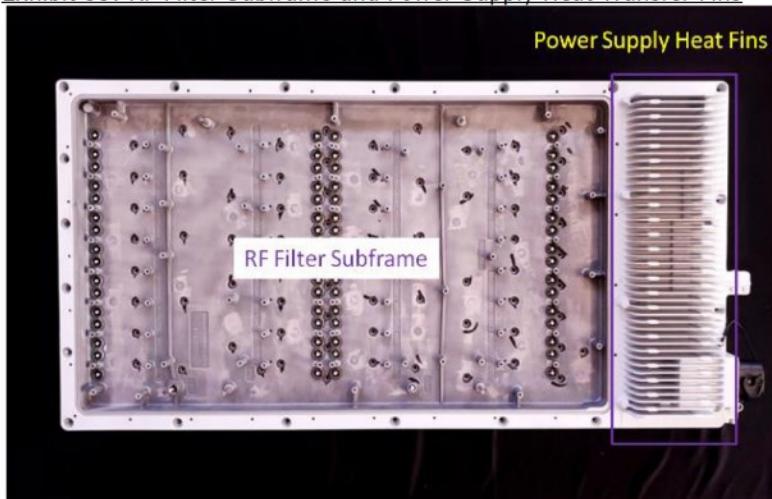
7. Power supply unit

PSU Integration into RF Filter Subframe

PSU located on front bottom portion of AAU and features its own heatsink

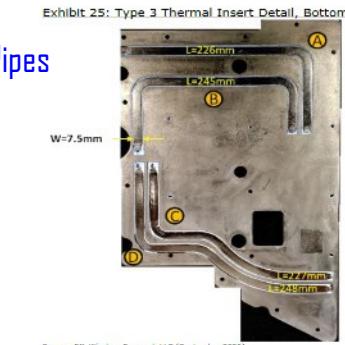
1. Integrated with RF Filter Subframe
2. 5 types of heat spreading fins indicate intricacy of heat management

Exhibit 33: RF Filter Subframe and Power Supply Heat Transfer Fins



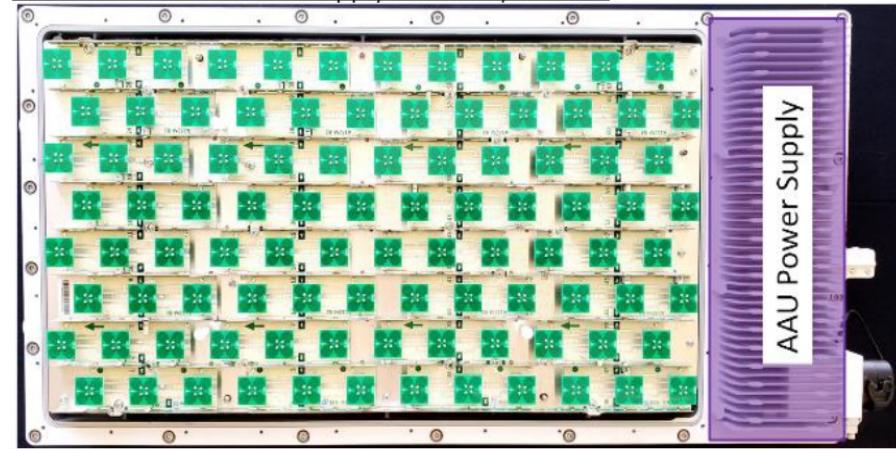
Source: EJL Wireless Research LLC (September 2020)

Dedicated Heat Pipes



Source: EJL Wireless Research LLC (September 2020)

Exhibit 39: AAU Power Supply Location, Bottom



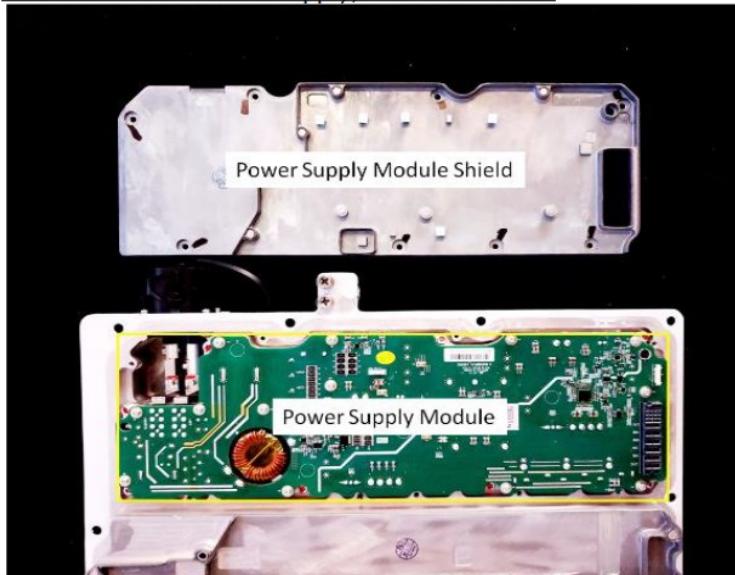
Source: EJL Wireless Research LLC (September 2020)

7. Power supply unit

Power Supply System (PSU)

1. Lots of thermal grease used
2. PSU completely E-shielded including inner thin plastic insulation

Exhibit 41: AAU Power Supply, Shield Removed

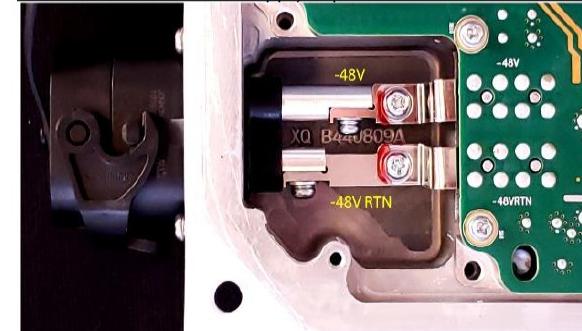


Source: EJL Wireless Research LLC (September 2020)

The AAU power supply electrical specifications are:

- P/N: PPC34 D033(V1.0)
- Weight: 1.67kg
- Dimensions: 396mm x 125mm x 20/24.5mm
- Vin = -36 to -57V, 58A MAX
- Vout1 = 30V, 19.2A (576W)
- Vout2 = 12V, 34.4A (412.8W)
- Vout3 = 12V, 36.8A (441.6W)
- Total Power = 1430.4W

Exhibit 43: AAU Power Supply Input Terminal Busbar Detail

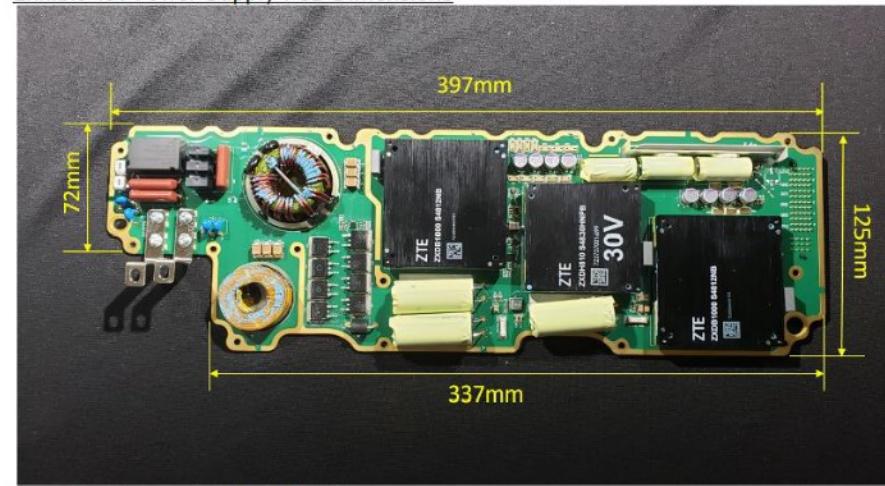


Source: EJL Wireless Research LLC (September 2020)

7. Power supply unit PCB Design

- 6-layer PCB, 1kg with all components
- 3 ZTE DC-DC converter brick modules, 2 wound inductors L1, (L2 is common mode choke)
- DC-DC converters:
 - Two +12V (from -48V) 1kW supplies, (1) to supply L1 modem and eCPRI fronthaul and (2) to supply MPSoC ICs and digital ICs in transceiver
 - One +30V 810W to supply (from -48V) LDMOS drivers and Doherty PA's
- 3 1000 μ F 100V capacitors on inputs of DC-DC modules
- 50V electrolytic capacitor on output of +30V DC-DC supply
- 12V electrolytic capacitors on outputs of +12V DC-DC supplies
- PSU input protected by gas discharge tubes, thermal fuses, surge protection unit
- 12V current sense transformer is present
- dedicated connector is used to interface the radio transceiver PCB
- ground plane segmentation on PSU PCB (isolation of components)

Exhibit 49: Power Supply PCB Dimensions



Source: EJL Wireless Research LLC (September 2020)

7. Power supply unit

Additional PSU Components and EM Shielding

- Infineon power 150V, 100A N-channel MOSFETs
- I²C interface is used on 26V, 12-bit TI Output Current/Voltage/Power Monitor IC
- I²C interface is used on 512 K-bit STMicro EEPROM IC
- 500mA low-noise adjustable LDO by MaxLinear
- ±2°C, 2.7-5V TI Temp Sensor
- 4x4mm integrated ON_Semi DC-DC converter
- TI dual diff. comparator
- Microchip 8-bit 64KB flash microcontroller
- Si-Labs bi-directional dual-channel 1.7MHz I²C isolators

PSU EMI (Electro-Magnetic Interference) reduction

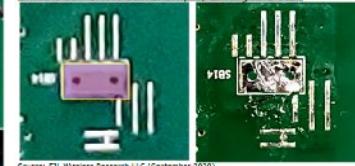
- a. Short solid metal blocks with through holes surround some components
- b. Miniature antenna structures on PCB to break/dissipate EM fields

Exhibit 55: SA3/SA4 (L) and SA5/SA6 (R) Locations



Source: EJL Wireless Research LLC (September 2020)

Exhibit 53: Short bar Example, Enlarged Detail

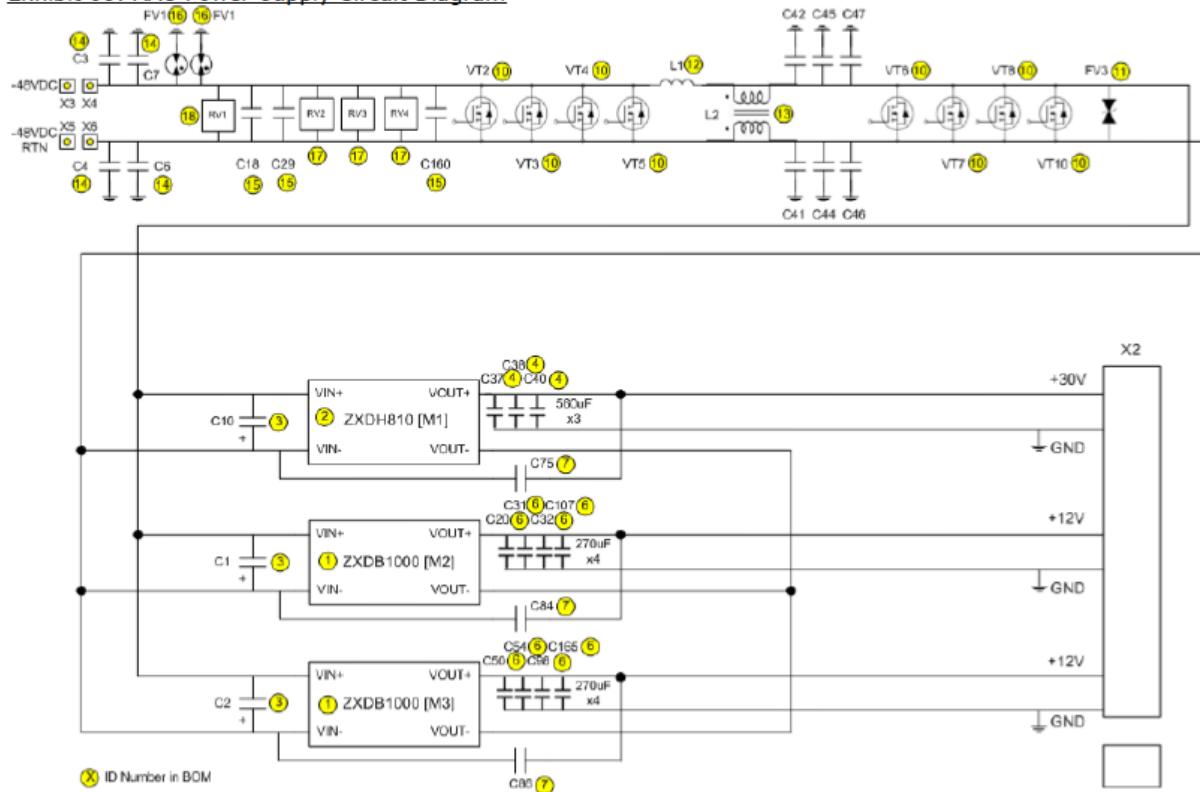


Source: EJL Wireless Research LLC (September 2020)

7. Power supply unit

Additional PSU Components and EM Shielding

Exhibit 60: AAU Power Supply Circuit Diagram



Source: EJL Wireless Research LLC (September 2020)

Table 1: AAU Power Supply PCB Top

ID Function

- 1 DC-DC Converter Module, Shielded, 1kW, Vin=-48, Vout=12
- 2 DC-DC Converter Module, Shielded, 810W, Vin=-48, Vout=30
- 3 Capacitor, Electrolytic, 1000uF, 100V
- 4 Capacitor, Electrolytic, 560uF, 50V
- 5 DC Voltage Busbar
- 6 Capacitor, Electrolytic, 270uF, 16V
- 7 Capacitor, Metallized Polypropylene Film, EMI, 0.1uF, 20%, 275VAC
- 8 Fuse, 30A, 72V
- 9 Inductor, Power, Shielded, 0.18uH
- 10 MOSFET, N-Channel, 150V, 100A
- 11 TVS Diode, Axial, 15kW, 75V
- 12 Inductor, Power
- 13 Inductor, Power, Common Mode Choke
- 14 Capacitor, 150pF, 10%, Safety Rated X1 440/Y2 300
- 15 Capacitor, Metallized Polyester Film (Dipped), 3.3uF, 5%, 250V
- 16 Gas Discharge Tube, 2-terminal
- 17 Thermal Fuse/MOV, 50V/3kA
- 18 Surge Protection Device Module, Vdc=65, 400V
- 19 Terminal Bars
- 20 ±2°C, 2.7V to 5.5V Temp Sensor
- 21 Integrated DC-DC Converter
- 22 LDO, Low Noise, 500mA, Adjustable
- 23 Transformer, Current Sense
- 24 Diode
- 25 Diode

Source: EJL Wireless Research LLC (September 2020)

Table 2: AAU Power Supply PCB Bott

ID Function

- 1 26V, 12-bit, I2C Output Current/Voltage/Power Monitor
- 2 Diode, Rectifier, 1000V, 1A
- 3 Dual Differential Comparator
- 4 Transistor, NPN, 100V, 6A
- 5 Optocoupler, Viso = 3,750Vrms, CTR=300%
- 6 Fuse, 30A, 72V
- 7 LDO, Low Noise, 500mA, Adjustable
- 8 8-bit Flash Microcontroller, 64KB
- 9 Bidirectional I2C Isolators, Dual Channel, 1.7MHz
- 10 ±2°C, 2.7V to 5.5V Temp Sensor with I2C/SMBus Interface
- 11 512-Kbit serial I2C bus EEPROM
- 12 Connector, 8-pin, Male, Rt Angle
- 13 Connector, 72-pin, Female



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