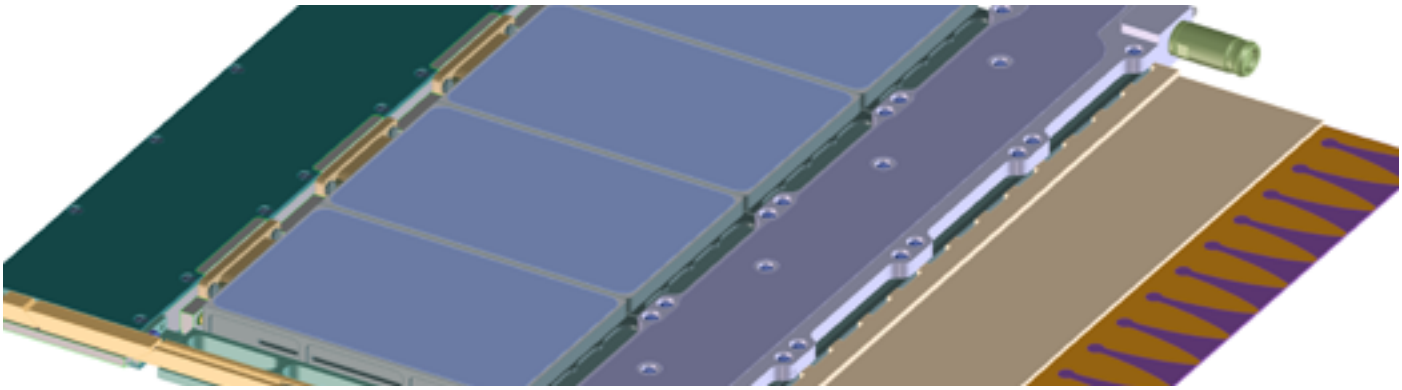
# X-Band 4 x QTRM Plank Product Capability

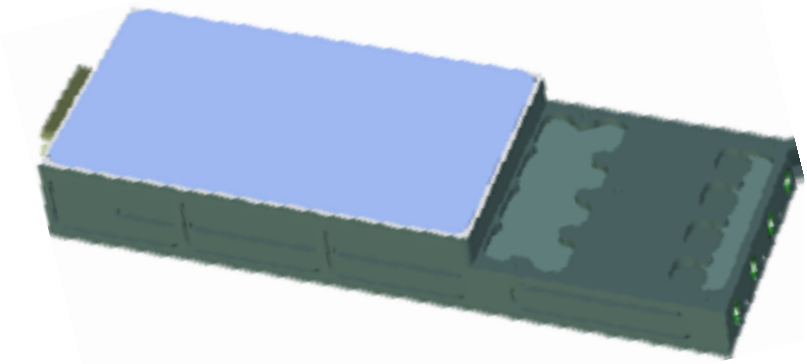
MA-100002



## Description

The X-band Plank described below contains four Quad Transmit Receive Modules providing sixteen ports which can be connected to individual antenna elements to form a 1-D phased array active antenna unit. Three M2 threaded holes in the end of each QTRM facilitates the attachment of a quad antenna module. Alternatively, equal length, low loss microwave cables can be used to connect to individual antenna elements in which case the holes could be used to attach a plate fitted with four cables.

Provision for liquid cooling allows continuous transmission of long pulse widths at high duty cycles through all sixteen elements simultaneously, thus creating a high power transmitter pulse at X-band. A closed loop cooling system comprising of a fluid reservoir, pump and heat exchanger can be used to pump the coolant through the Plank.



QTRM

- Common module 'Building Block'
- 4-Channel integrated assembly comprising of DC, Logic CTRL/Interface & T/R Module
- Designed for high volume manufacture
- Minimal alignment, custom ATE for factory 'calibration'

## Description

The Plank is supplied from a single 28 volt DC supply and contains the necessary supply conditioning to power the four QTRM's. A power-up sequence ensures that the input current surge is managed both within the individual QTRM's and within the Plank so as to avoid overloading the primary 28 volt supply on switch-on.

In addition, a half-duplex, asynchronous, RS485 bus allows communication to and from an external Beam Steering Computer (BSC) that provides control and monitoring of the Plank and its QTRM's. The serial data takes the form of a number of messages assigned to either control the individual T-R elements or to retrieve information about their settings or health status. RF2M have developed a Graphical User Interface (GUI) to control and monitor the behaviour of the Plank and can be run from a laptop or desktop computer.

Timing is provided by either an internal or external 100MHz clock and is selected via the micro-D connector.

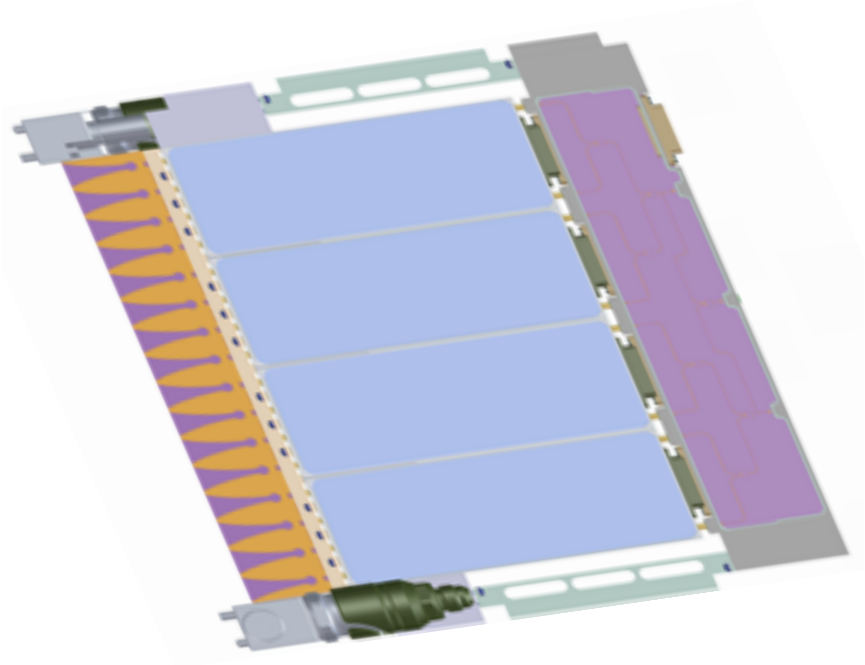
A transmitter power amplifier gating pulse must be provided to activate the PA power supplies just before the RF pulse arrives at the common RF I/O port. This is to ensure that any amplitude and phase transients caused by the PA's turning on do not interfere with the integrity of the RF pulse. All subsequent timing within the plank is derived from this TX PA gating pulse leading edge. The plank may be driven with a CW signal for test purposes as internal modulation is provided.

A scheduler mode can be selected which rapidly stores a maximum of sixteen, pre-determined beam steering coordinates. An external Beam Steer pulse must be provided by the BSC to step through the schedule to allow very fast beam switching.

The QTRM's are factory calibrated to minimise amplitude and phase variations over temperature and frequency, making them line-replaceable units. Additional calibration constants that are User system related can be uploaded to the QTRM's via the RS485 serial data link.

This product offering from RF2M Microwave provides the means to experiment with X-band phased array radar and to further develop a 2-D radar by stacking Planks up to eight deep. This product significantly reduces development time allowing customers to focus their valuable resources on radar signal processing and beam control.

RF2M Microwave would welcome the opportunity to work with customers during their product development by providing technical support to customise an active antenna array solution.



# Electrical Performance

Over $T_{OP}$ Unless Otherwise stated. Limits & Conditions are indicated values. Indicated values given per channel unless otherwise stated.

| Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|
| **Parameters: Transmit** | | | | | |
| Centre Frequency | | 9.5 | | GHz | See Note 1 |
| Operating BW | | 1 | | GHz | See Note 1 |
| Input Return Loss | | 10 | | dB | Common RF In/Out port |
| Output Return Loss | | 10 | | dB | Individual Antenna ports |
| Pulse Width | 3 | | 100 | µS | 80µS at 30% Duty max. |
| Duty Cycle | 5 | | 30 | % | 80µS at 30% Duty max. |
| RS485 Serial Data bus | | Differential | | | Asynchronous UART, half-duplex |
| Data Control Rate | | 5.0 | | Mbps | |
| TX PA Gating Pulse | | Differential | | | Gate TX PA on 2.6 µS before RF pulse, target 1 µS |
| Beam Steering Pulse | | Differential | | | Triggers Beam Direction change |
| No. of Stored Beam Settings | | | 16 | | Scheduler Mode |
| Beam Steer Data Transfer Time | | | 350 | µS | Time taken to re-load the Scheduler register |
| Plank Input Voltage Range | 26 | +28 | 30 | Volts | |
| Plank Input Current | | 8.5 | | Amps | Average current @ 28v, 30% duty |
| DC Input Consumption | | 238 | | Watts | Average power @ 28v, 30% duty |
| Beam former Insertion Loss | | 13 | | dB | To be confirmed |
| Selectable Int. or Ext. Clock | | 100 | | MHz | ±20ppm LVDS |
| **Parameters: Transmit** | | | | | |
| TX Psat | | 8.5 | | Watts(pk) | 8.5Watts output per antenna port at Fo |
| TX Input Power Level | | +20 | +23 | dBm | For Psat Out. |
| Spurious | | -60 | | dBc | |
| TX Phase Variation across pulse | | 4.0 | | deg | Across 80µS Pulse at 30% Duty |
| TX Amplitude Variation across pulse | | 0.5 | | dB | Across 80µS Pulse at 30% Duty |
| Harmonics | | -20 | | dBc | |
| TX Insertion Phase Balance | | ±15 | | deg | Between any two channels. Target ±10 |
| TX Power Balance | | ±2.0 | | dB | Between any two channels. Target ±1 |
| **Parameters: Receive** | | | | | |
| RX Output P1dB | | -4 | | dBm | |
| RX Gain | | 14 | | dB | See Note (2) & (3) |
| RX Input IP3 | | -8 | | dBm | |
| RX Noise Figure | | | 4 | dB | See Note (4). Target <3.5dB |
| Receiver Protection per Channel | | | 15 | Watts PK | Protection from reflected TX Power |
| RX Insetion Phase Balance | | ±15 | | deg | Between any two channels. Target ±10 |
| RX Gain Balance | | ±2.0 | | dB | Between any two channels. Target ±1 |

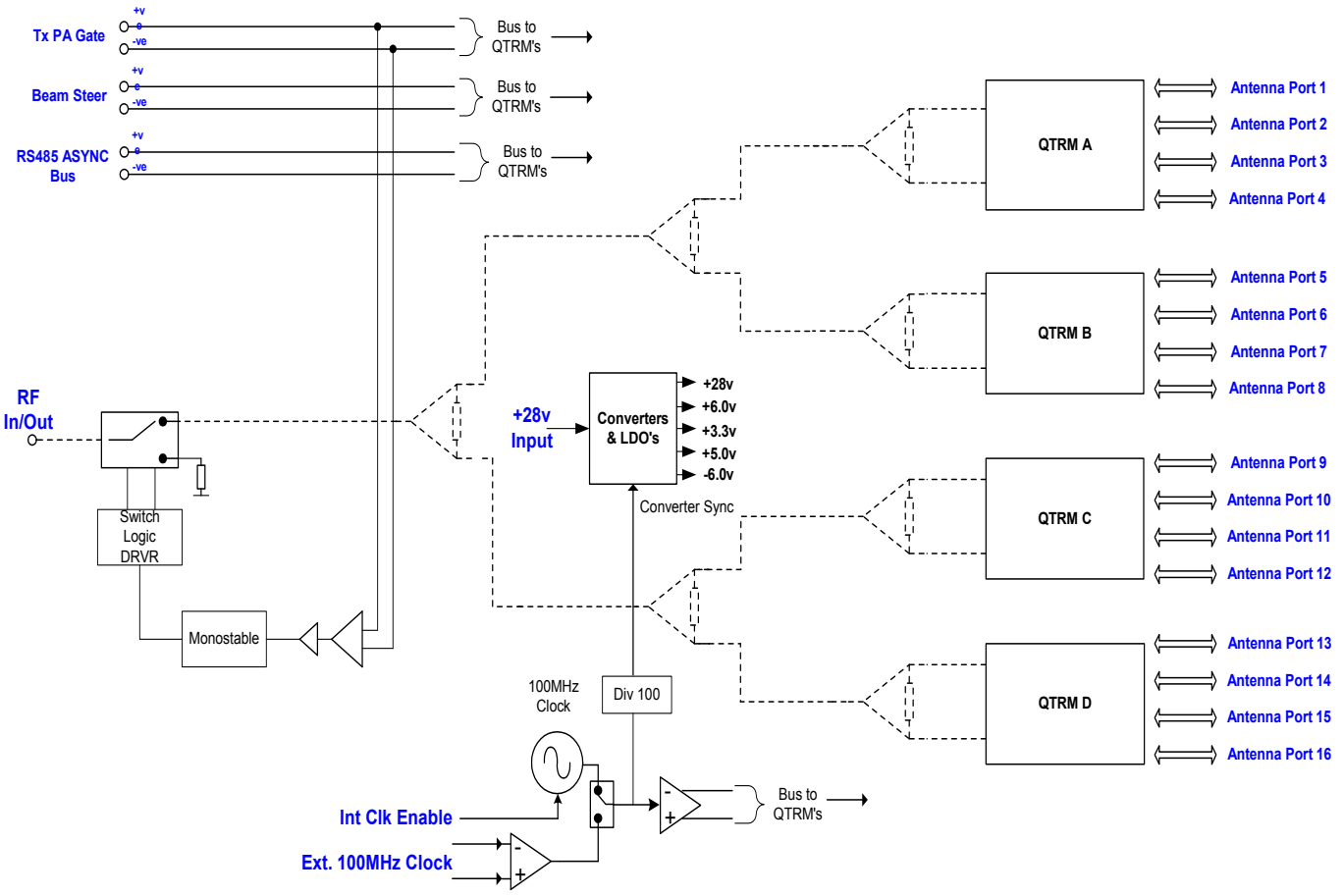
## Product Features

- RS485 Half-Duplex, 5.0 Mbps serial data bus for control and monitoring.
- Plank operating current and power supply health monitored and reported on request along with health status of each QTRM
- Automatic shut-down of individual QTRM's if their internal temperature reaches a critical limit where damage could occur. Hysteresis applies.
- Positive supplies inhibited (with the exception of the digital control circuits) if negative supply is lost
- Direction cosines used for beam steering
- QTRM's respond to individual address or broadcast messages.
- Module position assignment
- Sequenced QTRM power-up timing based on module position address
- Ability to schedule up to 16 phase & amplitude settings for rapid beam switching
- Ability to disable internal modulation and apply externally
- Array CAL allows end-user to add additional TRU phase & amplitude calibration.
- Read-back of CAL phase & amplitude values for each TRU.
- Selection of internal/external Clock source to allow synchronisation of multiple QTRM's.
- European Manufacture.

| Mechanical |
| --- |
| Approximate Size: 203mm(L) x 270mm(W) x 20mm(D) excluding connectors. See Note (5)<br>Approximate Mass: 1.2 Kg<br>RF Connectors: Male SMP shroud<br>DC Connector : 37-way Micro-D plug<br>Hydraulic Connectors : Staubli CGO 03 type, non-spill<br>Cooling Fluid : Glycol mix<br>Inlet Temperature : +48°C max.<br>Fluid Flow Rate : 1Litre/min<br>Outlet Temperature : approximately +58°C for an inlet temperature of +48°C<br>Pressure Drop : < 0.2 bar with a fluid flow rate of 1L/min |

| Environmental |
| --- |
| Operating Ambient: -30 to +70°C.<br>Assumes Plank Fluid Inlet Temperature is in the range +10 °C to +48 °C<br>Storage: -40 to +85°C<br>MTBF : TBD |
| **NOTES**<br>(1) Limited by circulator specification and physical dimensions of the QTRM<br>(2) Up to 3dB reduction in useable attenuation range due to Calibration.<br>(3) Figure given for Ref Attenuator state, Ref Phase State and includes Beam former losses.<br>(4) N.F. given for Ref Attenuator state, Ref Phase State and includes Beam former losses.<br>(5) Dimension "D" is for Demo Unit only. Potential to reduce to 14.1mm for a practical AESA configuration. See outline diagram in section 8 below. |

## Functional Block Diagram



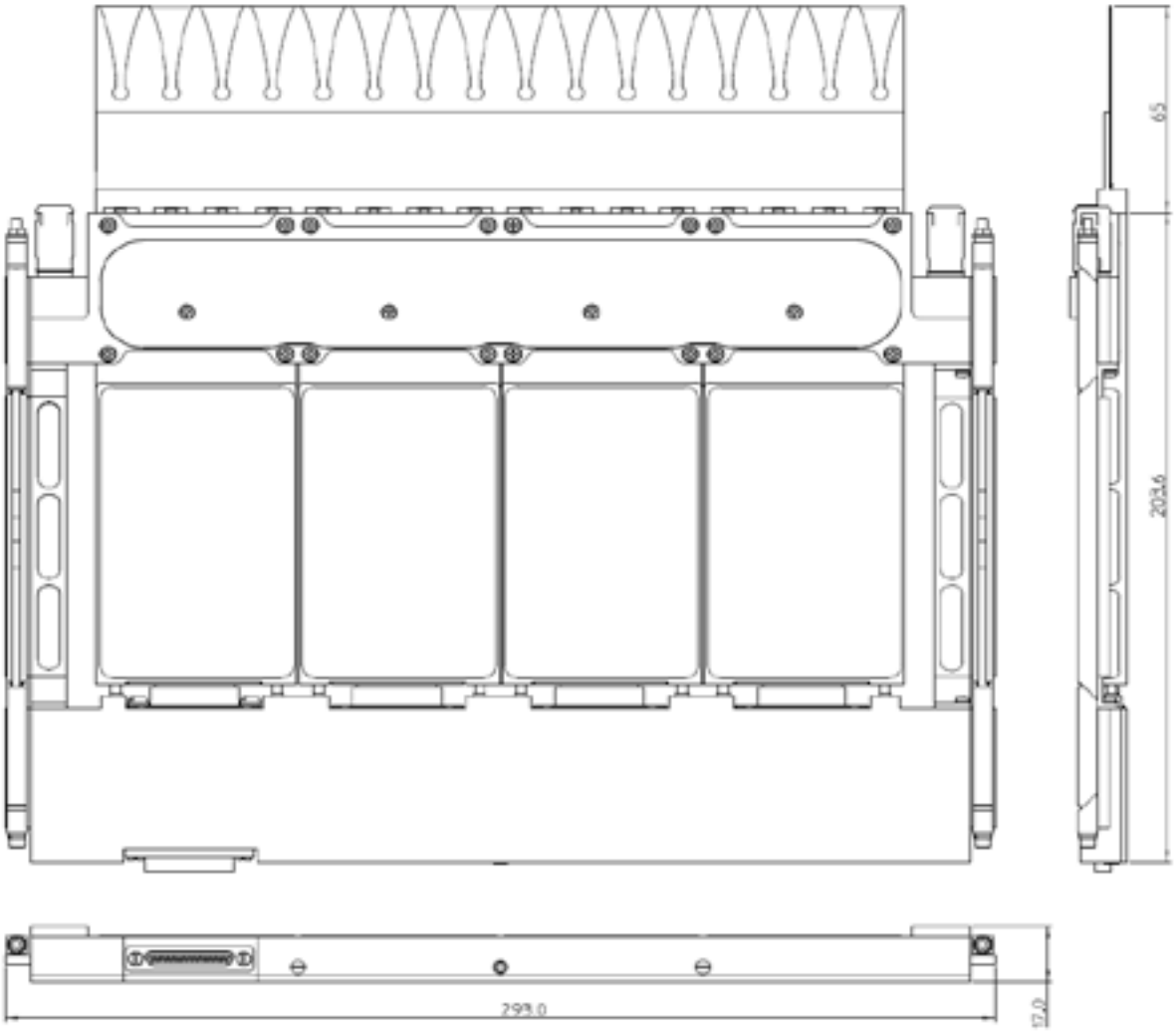

### **DC Pin-Out Connection's** (37-way Mirco-D)

| Pin No. | Description | Pin No. | Description | Pin No. | Description | Pin No. | Description |
|---|---|---|---|---|---|---|---|
| 1 | +28V | 11 (1) | Ext_CLK +ve | 21 | +28V | 31 | Spare |
| 2 | +28V | 12 | Signal GND | 22 | PSU GND | 32 | Spare |
| 3 | PSU GND | 13 | Spare | 23 | PSU GND | 33 | -6V Flag |
| 4 | PSU GND | 14 | +28V Flag | 24 | ADDR_1 | 34 | Pmon Flag |
| 5 | ADDR_0 | 15 | +6V1 Flag | 25 | Tx PA Gate +ve | 35 | ICC_Mon |
| 6 | ADDR_2 | 16 | +6V2 Flag | 26 | Signal GND | 36 | Spare |
| 7 | Tx PA Gate -ve | 17 | +5V Flag | 27 | RS485 -ve | 37 | Spare |
| 8 | RS485 +ve | 18 | Spare | 28 | Beam Steer +ve | | |
| 9 | Signal Gnd | 19 | Int_CLK Enable | 29 | Signal GND | | |
| 10 | Beam Steer -ve | 20 | +28V | 30 | Ext_CLK -ve | | |

**Notes**

(1) External Clock (if used) 100MHz LVDS ±20ppm max.

# Preliminary Outline Diagram



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