mmTron
Unleashing the mmWave Frontier

TMC165
24-30 GHz Front-End Module

Product Features

- RF frequency: 24 to 30 GHz
- Linear Gain: 23 dB
- Noise Figure: 3.5dB
- Psat: 30 dBm
- Bare Die: X=3.4, Y=3.0, Z=0.1 mm
- Package Size: 20-pin, X=5.0, Y=5.0 mm
- DC Power:
  TX: 6 VDC, 740 mA
  RX: 3V, 35mA
- Drain switch requires an additional 4mA current in RX mode

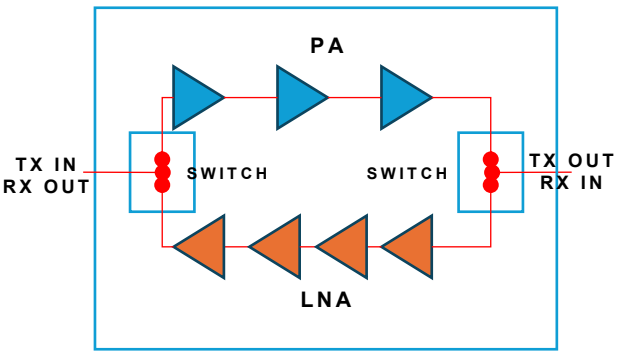
Applications

- Radar
- SATCOM
- mmWave 5G FWA
- Point-to-Point Radios and VSATs
- Fiber Optics
- Military, EW and Space

Product Description

The TMC165 GaAs Front-End Module is a high linearity device, available in bare die or in a 5x5 QFN package, designed for use in Radar, mmWave FWA, Radios, Military, EW and Space applications.
The TMC165 is a 50Ω matched design providing more than 29dBm of output power and less than 3.5dB of Noise Figure from 24 to 30 GHz and eliminates the need for RF port matching. TMC165 has >> 1GHz video bandwidth an on-chip drain switch to set VDRX = 0V in TX mode. It has positive logic SPDT RF switches on both sides of chip for switching between TX and RX modes.
TXIN / RXOUT and TXOUT / RXIN are DC grounded with shunt inductors.
Both bond pad and backside metallization are Au-based that is compatible with ribbon and wedge bonding and high conductivity epoxy and eutectic die attach methods. TMC165 has on Chip Detector and ESD protection supporting 2kV HBM. The bare die version is available under TMC165-D, and the SMT version under TMC165-P5.

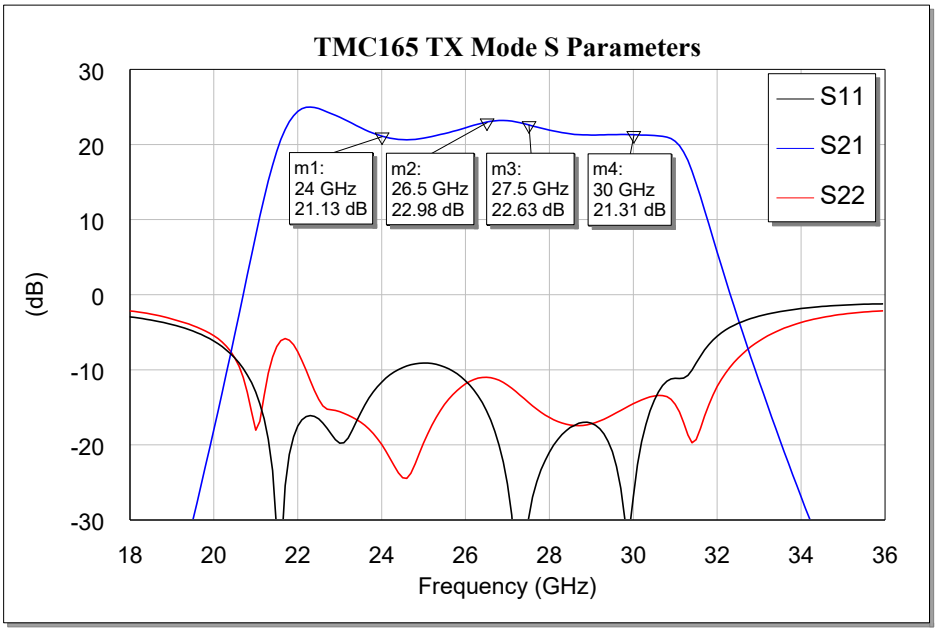
Functional Block Diagram

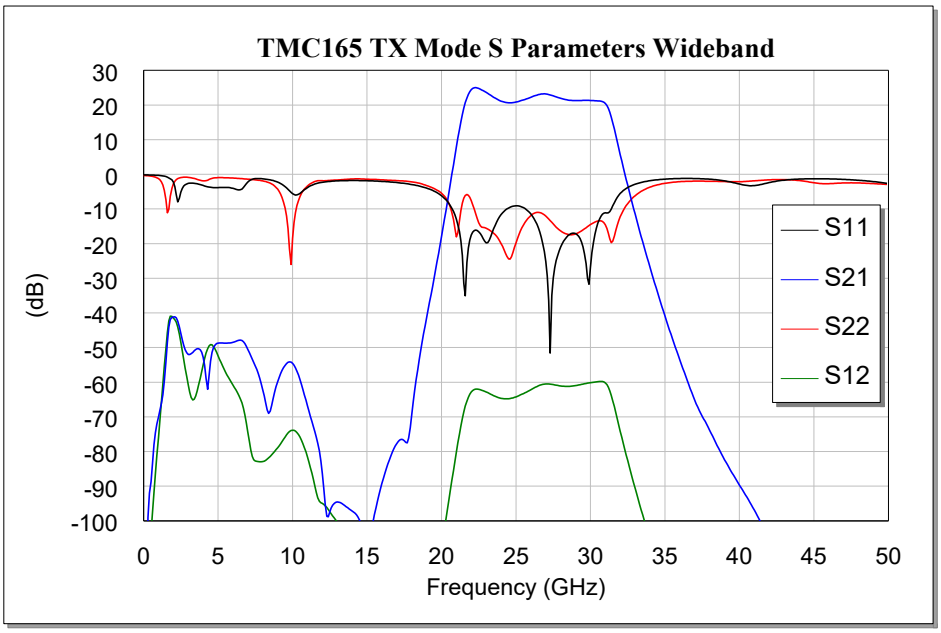


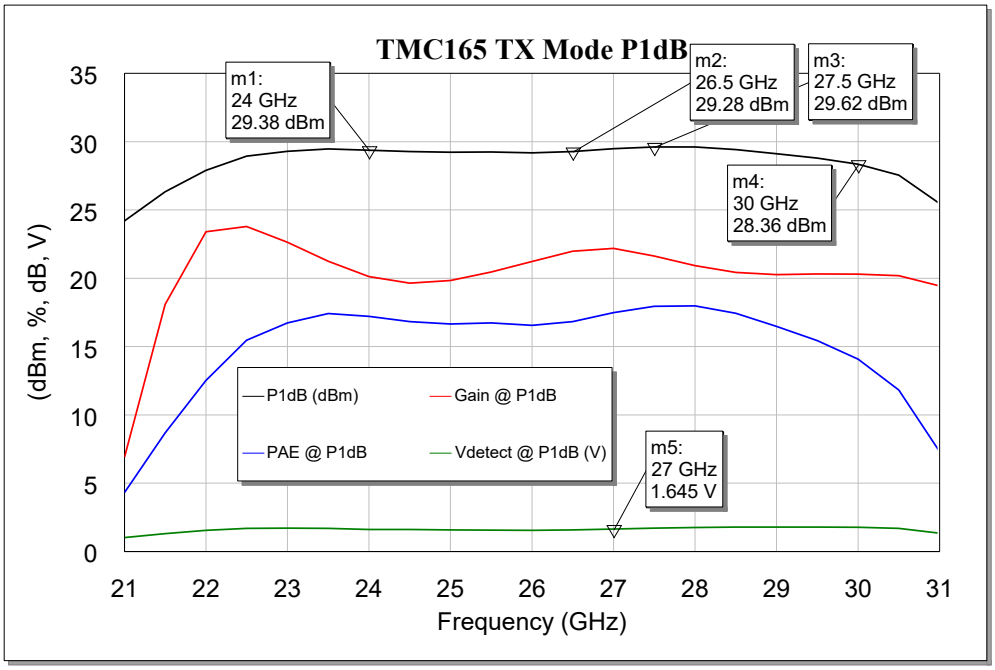
Ordering Information

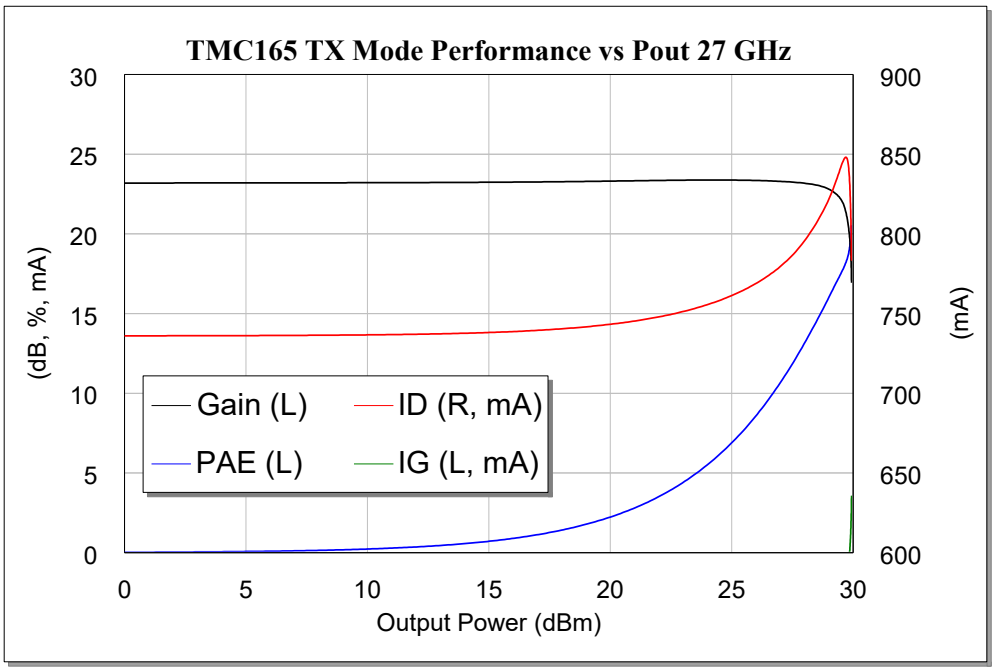
Part No.	Description
TMC165-D	Bare Die
TMC165-P5	Packaged Device

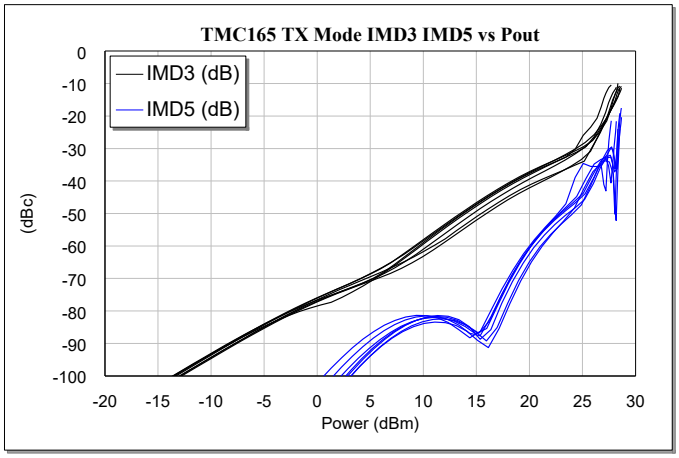
Parameter	Units	Range 1	Range 2
Frequency	GHz	24 - 30	26.5 – 27.5
Gain	dB	21	22
Output TX P1dB	dBm	29	30
Noise Figure	dB	< 3.9	< 3.5
TX OIP3	dBm	>36	> 37
RX IIP3	dBm	> 2.5	> 5
Input RX IP1dB	dBm	10	11
Input Return Loss	dB	10	15
Output Return Loss	dB	10	10
Switch Rise Time	nS	15	15
Switch Fall Time	nS	10	10
Video Bandwidth	MHz	> 1000	
Power Consumption (TX)	mW	4450	
Power Consumption (RX)	mW	105	
Bias Point (TX)	V,mA	6V, 740mA	
Bias Point (RX)	V,mA	3V, 35mA	

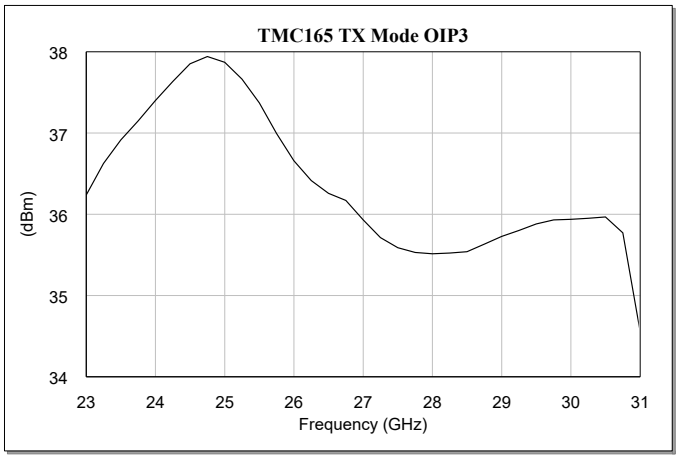

TMC165 TX Mode S Parameters
30
20
10
0
-10
-20
-30
(dB)
18
20
22
24
26
28
30
32
34
36
Frequency (GHz)
m1:
24 GHz
21.13 dB
m2:
26.5 GHz
22.98 dB
m3:
27.5 GHz
22.63 dB
m4:
30 GHz
21.31 dB
S11
S21
S22

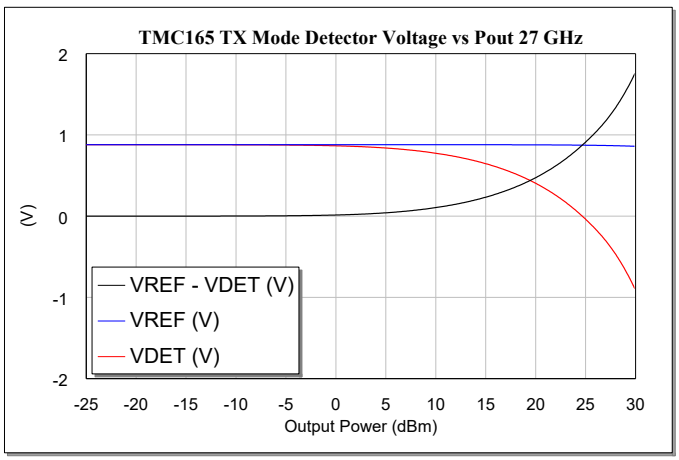

TMC165 TX Mode S Parameters Wideband
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
(dB)
0
5
10
15
20
25
30
35
40
45
50
Frequency (GHz)
S11
S21
S22
S12

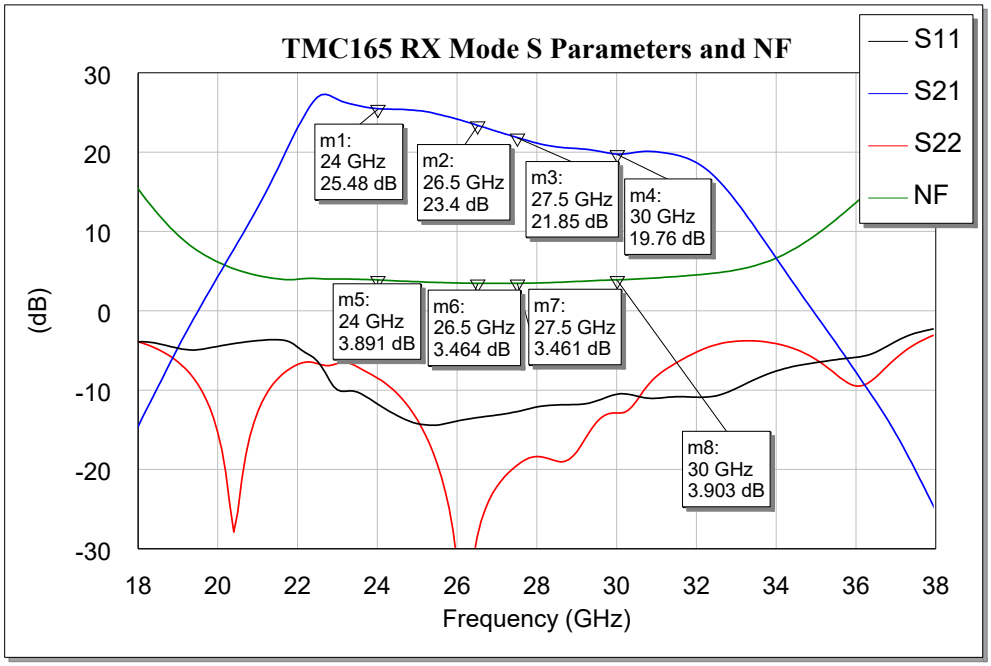

TMC165 TX Mode P1dB
m1:
24 GHz
29.38 dBm
m2:
26.5 GHz
29.28 dBm
m3:
27.5 GHz
29.62 dBm
m4:
30 GHz
28.36 dBm
m5:
27 GHz
1.645 V
P1dB (dBm)
Gain @ P1dB
PAE @ P1dB
Vdetect @ P1dB (V)
(dBm, %, dB, V)
Frequency (GHz)
35
30
25
20
15
10
5
0
21
22
23
24
25
26
27
28
29
30
31

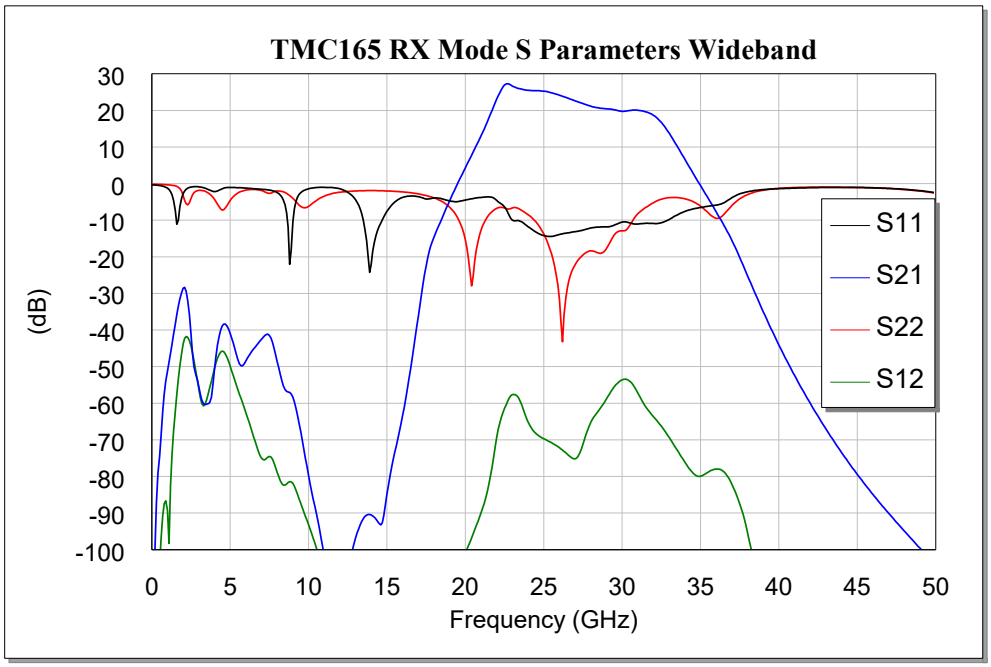

TMC165 TX Mode Performance vs Pout 27 GHz
Gain (L)
ID (R, mA)
PAE (L)
IG (L, mA)
(dB, %, mA)
(mA)
Output Power (dBm)
30
25
20
15
10
5
0
900
850
800
750
700
650
600
0
5
10
15
20
25
30

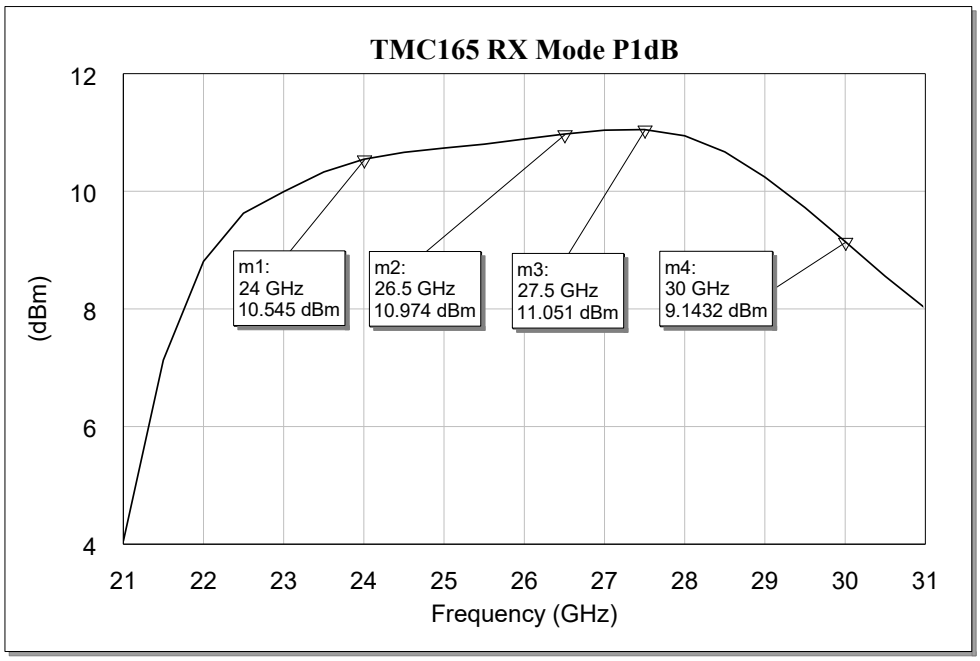

TMC165 TX Mode IMD3 IMD5 vs Pout
IMD3 (dB)
IMD5 (dB)
(dBc)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-20
-15
-10
-5
0
5
10
15
20
25
30
Power (dBm)

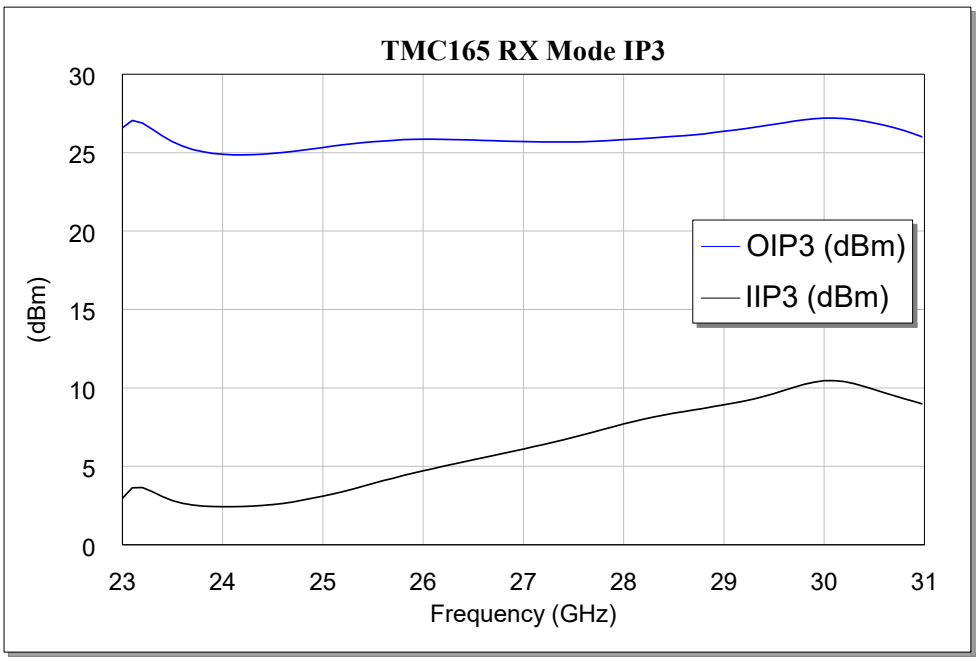

TMC165 TX Mode OIP3
(dBm)
38
37
36
35
34
23
24
25
26
27
28
29
30
31
Frequency (GHz)


TMC165 TX Mode Detector Voltage vs Pout 27 GHz
(V)
2
1
0
-1
-2
VREF - VDET (V)
VREF (V)
VDET (V)
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
Output Power (dBm)


TMC165 RX Mode S Parameters and NF
S11
S21
S22
NF
m1:
24 GHz
25.48 dB
m2:
26.5 GHz
23.4 dB
m3:
27.5 GHz
21.85 dB
m4:
30 GHz
19.76 dB
m5:
24 GHz
3.891 dB
m6:
26.5 GHz
3.464 dB
m7:
27.5 GHz
3.461 dB
m8:
30 GHz
3.903 dB
(dB)
Frequency (GHz)


TMC165 RX Mode S Parameters Wideband
S11
S21
S22
S12
(dB)
Frequency (GHz)


TMC165 RX Mode P1dB
12
10
8
6
4
(dBm)
m1:
24 GHz
10.545 dBm
m2:
26.5 GHz
10.974 dBm
m3:
27.5 GHz
11.051 dBm
m4:
30 GHz
9.1432 dBm
21
22
23
24
25
26
27
28
29
30
31
Frequency (GHz)


TMC165 RX Mode IP3
30
25
20
15
10
5
0
(dBm)
OIP3 (dBm)
IIP3 (dBm)
23
24
25
26
27
28
29
30
31
Frequency (GHz)

- **Product Operation**
- **TX is controlled by setting VGTX and VGRX.**
- **Nominal switch control signals are V, 6V.**
- **LNA has a drain switch which will automatically set VDTX = 0V when in TX mode (overriding the VDRX setting applied to the chip). LNA current controlled with VGRX.**
- **VNGEGRX of -2V required for LNA drain switch.**

- **RX to TX Mode Switching (and vice versa)**
  - RX to TX: Apply 0V to VCRX, wait TBD nS, Apply 6V to VCTX, Apply TX Mode VGTX
  - TX to RX: Apply 0V to VCTX and RX Mode VGTX, wait TBD nS, Apply 6V to VCRX

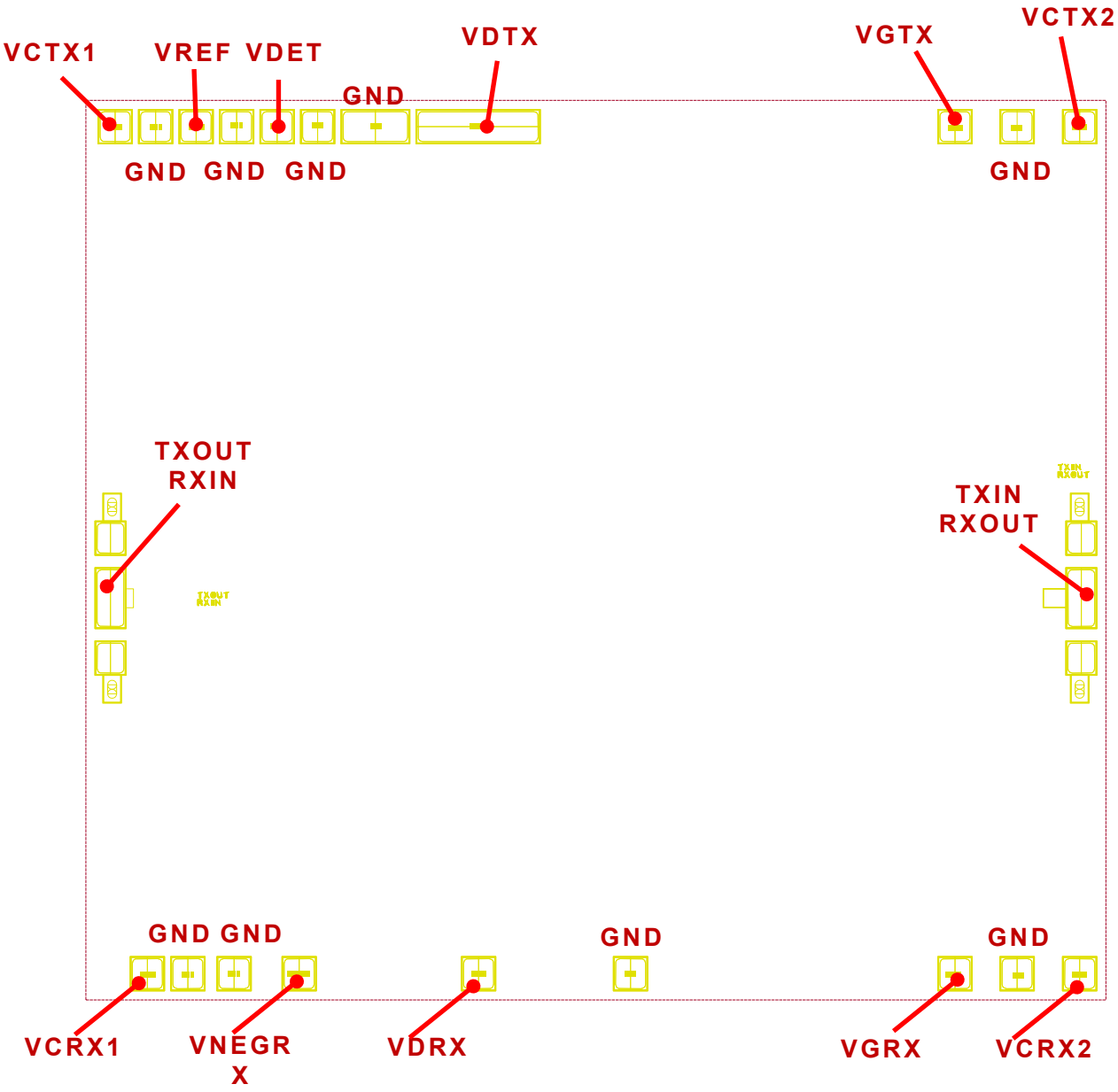
- **Turn Off Sequence**
  - Apply 0V to both VCRX and VCTX. Apply 0V to VDRX and VDTX. Turn off remaining supplies

- **Turn On Sequence TX Mode**
  - Apply all voltages shown in OFF mode, order does not matter
  - Apply VDRX and VDTX, order does not matter
  - Apply VCRX and VCTX per TX Mode, apply VCRX first, VCTX second
  - Current search VGTX for desired quiescent VDTX current (736mA nominal)

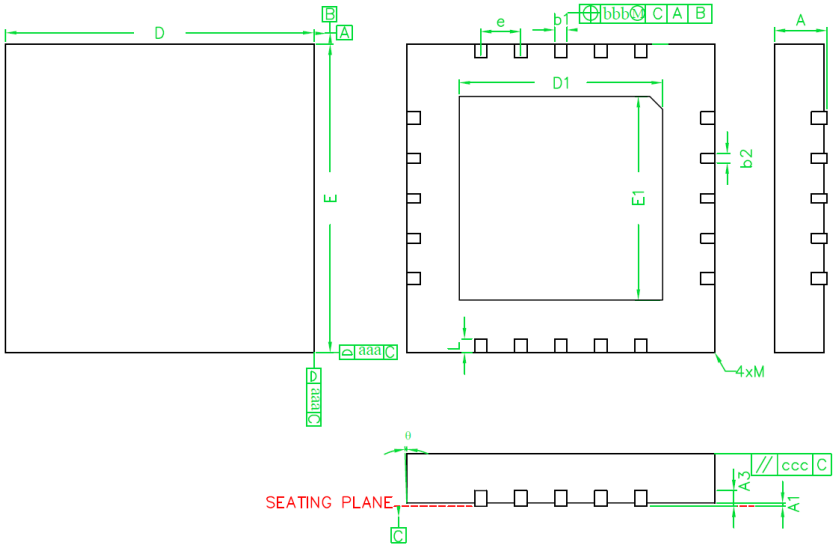
- **Turn On Sequence RX Mode**
  - Apply all voltages shown in OFF mode, order does not matter
  - Apply VDRX and VDTX, order does not matter
  - Apply VCRX and VCTX per RX Mode, apply VCRX first, VCTX second
  - Current search VGRX for desired quiescent VDRX current (35mA nominal)

Parameter	TX Mode	RX Mode	OFF Mode
VCRX (both)	0	6	0
VCTX (both)	6	0	0
VDTX	6	6	0
VDRX	3	3	0
VNEGRX	-2	-2	-2
VGTX	-0.66	-2	-2
VGRX	-1	-1	-2

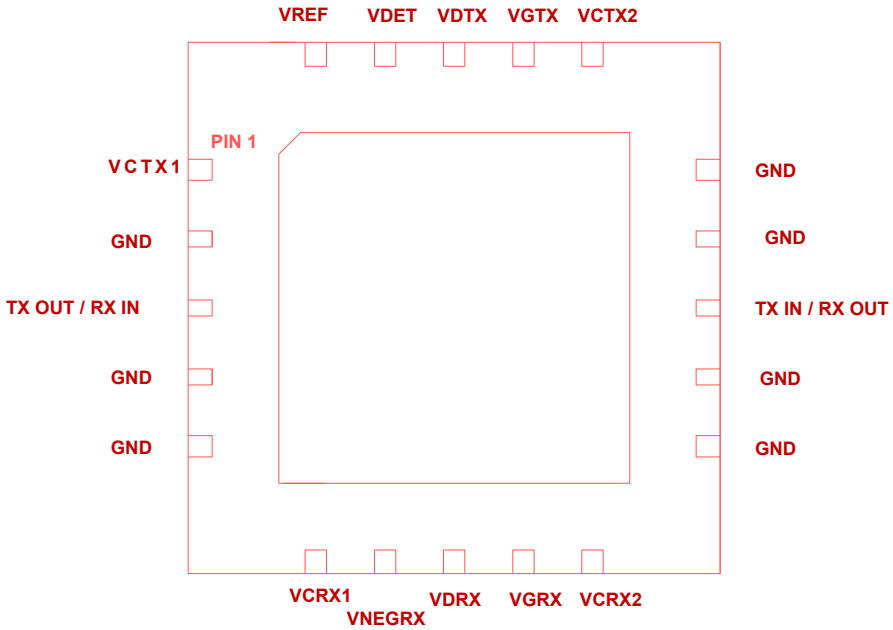
- **Off-Chip Components**
- **VDRX, VDTX**
    - Off chip bypass in decades, 100pF – 10uF, baseline no de-Q resistance on shunt caps
- **VGRX, VGTX**
    - Off chip bypass in decades, can use 10Ω de-Q resistance for the shunt caps
- **VNEGRX**
    - Strictly for negative rails to control the LNA drain switching function. Resistance impacts leakage current (between VCRX and VNEGRX). May place a series resistor / bypass capacitor off chip.
- **VCTX1, VCRX1, VCTX2, VCRX2**
    - No off-chip component is necessarily, we suggest having a small series R, shunt C option in the PCB layout.
- **VREF, VDET**
    - Apply VDTX voltage to the VREF and VDET pad through a 25 kΩ resistors. Voltages are measured on the die side of the resistors.,


VCTX1
VREF VDET
GND
VDTX
VGTX
VCTX2
GND GND GND
GND
TXOUT
RXIN
TXIN
RXOUT
GND GND
GND
GND
VCRX1
VNEGR
X
VDRX
VGRX
VCRX2

Package Drawing, 5x5, 20-pin, 0.65mm pitch



SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	0.80	0.90	1.00
A1	0	0.02	0.05
A3	----	0.25REF.	----
b1	0.15	0.20	0.25
b2	0.10	0.15	0.20
D	4.90	5.00	5.10
D1	----	3.30BSC	----
E	4.90	5.00	5.10
E1	----	3.30BSC	----
e	----	0.65BSC	----
L	0.18	0.23	0.28
θ	0	----	12°
aaa	----	0.25	----
bbb	----	0.10	----
ccc	----	0.10	----
M	----	----	0.05



DXF file is available upon request

Recommended Biasing

The TMC165 is operated with both positive supply VD and negative supply VG as well as switch control signals.

Assembly Techniques

The TMC165 is fabricated using a GaAs-based semiconductor material structure and may be used packaged in a standard overmold or an air-cavity QFN or used as a die.



Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. mmTron Inc. recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications. III-V MMICs are ESD-sensitive. Preventative ESD measures must be employed in all aspects of storage, handling, and assembly. MMIC ESD precautions, handling considerations, and die-attach and bonding methods are critical factors in successful III-V MMIC performance and reliability.



RoHS Compliant

This part is RoHS compliant, meeting the requirements of the EU Restriction of Hazardous Substances Directive 2002/95/EC, commonly known as RoHS. Six substances are regulated: lead, mercury, cadmium, chromium VI (hexavalent chromium), polybrominated biphenyls (PBB), and polybrominated biphenyl ethers (PBDE). RoHS compliance requires that any residual concentration of these substances is below the Directive's maximum concentration values (MCV): cadmium 100ppm by weight and all others 1000ppm by weight.

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