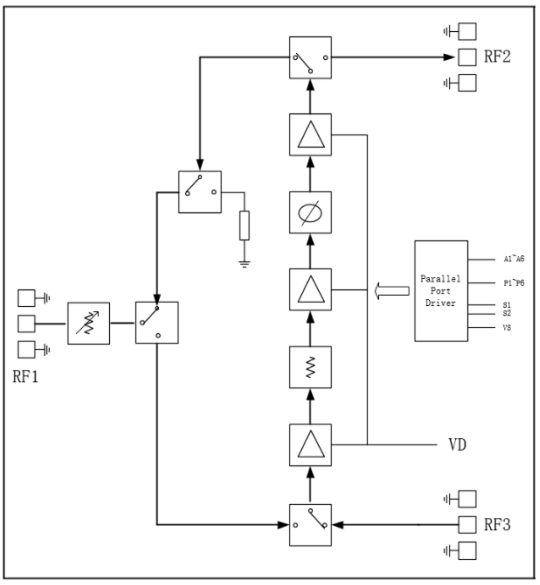
1. Description

- The M7113E(M) is a Multi-Function MMIC integrated Amplifier, 6-bit Digital Phase-Shifter, 6-bit Digital Attenuator, Temperature Compensation Circuit, SPDT Switch and Digital Control Circuit, fabricated on GaAs p-HEMT MMIC process. It operates over 5-13GHz, the OP-1dB of Rx is 10dBm with 12dB gain and 7dB noise figure, the PSAT of Tx is 17dBm with 13dB gain. It provides 360° of phase coverage with a LSB of 5.625° and 31.5dB of attenuation coverage with a LSB of 0.5dB. It achieves a low RMS phase error of 3° with amplitude error of 1dB and a low RMS attenuation error of 0.25dB with relative phase of 3°.



M7113E(M)-PDS-F01

Figure 1. M7113E(M) Functional Block Diagram

2. Applications

- TX/RX Modules
- Defense

3. Features[1]

- Frequency Range: 5-13GHz
- TX Small Signal Gain: 15dB
- TX VSWR: 1.5/1.5
- TX Saturated Output Power: 17dBm
- TX Dynamic Current at OPSAT: 140mA
- RX Small Signal Gain: 14dB
- RX VSWR: 1.6/1.5
- RX Noise Figure: 7dB
- RX Output P-1dB: 12dBm
- RX Dynamic Current at OP-1dB:110mA
- RMS Phase Error: 3°
- Amplitude Error: 1dB
- RMS Attenuation Error: 0.25dB
- Relative Phase: 3°
- Die Size: 3.5 x 4.5 x 0.1mm

[1] On-wafer Test

4. Brief Typical Performance

Table 1. Brief Typical Performance

Parameter	5-13GHz	Units
TX Small Signal Gain	13	dB
TX Output PSAT	17	dBm
TX Dynamic Current at PSAT	140	mA
RX Small Signal Gain	12	dB
RX Noise Figure	7	dB
RX Output P-1dB	10	dBm
RX Dynamic Current at OP-1dB	110	mA
RMS Phase Error	3	°
Amplitude Error	1	dB
RMS Attenuation Error	0.25	dB
Relative Phase	3	°

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5. Recommended Operating Conditions

Table 2. Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Units
Operating Temperature Range	-55	25	125	°C
Supply Voltage, VS	-	-5	-	V
R_X/T_X Supply Voltage, VD	-	5	-	V
T_X/R_X/Load Control Voltage, S1/S2	-	0/5	-	V
6-bit Digital Attenuator Control Voltage, A1-A6	-	0/5	-	V
6-bit Digital Phase Shift Control Voltage, P1-P6	-	0/5	-	V

6. RF Characteristics (T_C = 25˚C)

Table 3. RF Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
T_X Small Signal Gain	$S21_T_X$	-	13	-	dB
T_X $VSWR_{in}$	$VSWR_{in}_T_X$	-	1.5	-	-
T_X $VSWR_{out}$	$VSWR_{out}_T_X$	-	1.5	-	-
T_X Saturated Output Power	$P_{SAT}_T_X$	-	17	-	dBm
T_X Dynamic Current at P_{SAT}	$I_d_T_X$	-	140	-	mA
R_X Small Signal Gain	$S21_R_X$	-	12	-	dB
R_X $VSWR_{in}$	$VSWR_{in}_R_X$	-	1.6	-	-
R_X $VSWR_{out}$	$VSWR_{out}_R_X$	-	1.5	-	-
R_X Noise Figure	NF	-	7	-	dB
R_X Output P_{-1dB}	$OP_{-1dB}_R_X$	-	10	-	dBm
R_X Dynamic Current at OP_{-1dB}	$I_d_R_X$	-	110	-	mA
RMS Phase Error	RMS (°)	-	3	-	°
Amplitude Error	ΔIL	-	1	-	dB
RMS Attenuation Error	RMS_A	-	0.25	-	dB
Relative Phase	RMS_P	-	3	-	°

7. Typical Performance Curve

■ Small-signal Characteristics Curve (25℃)

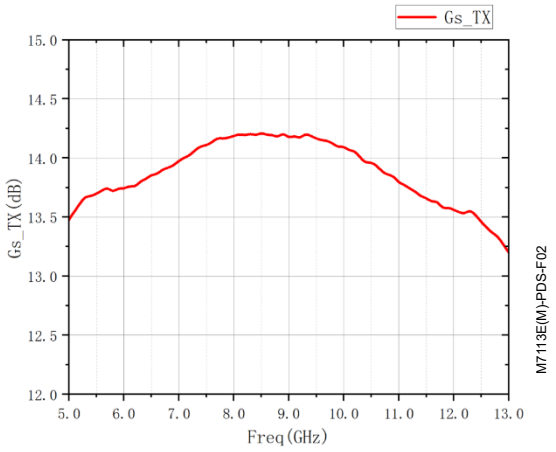


Figure 2. T_X Small-signal Gain Characteristics

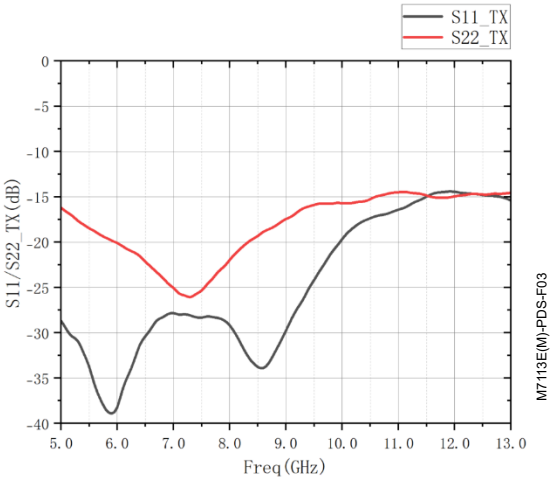


Figure 3. T_X Small-signal RL Characteristics

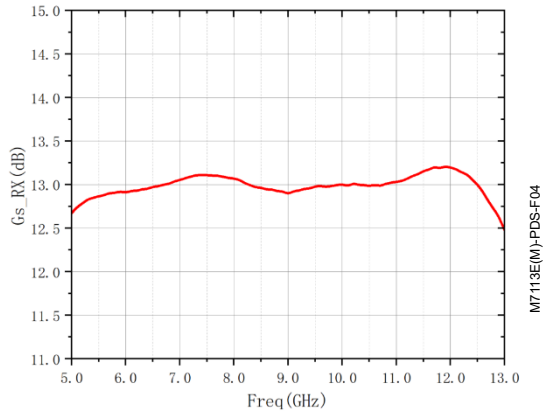


Figure 4. R_X Small-signal Gain Characteristics

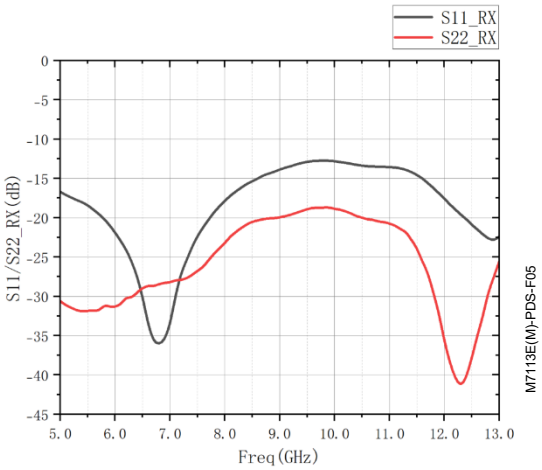


Figure 5. R_X Small-signal RL Characteristics

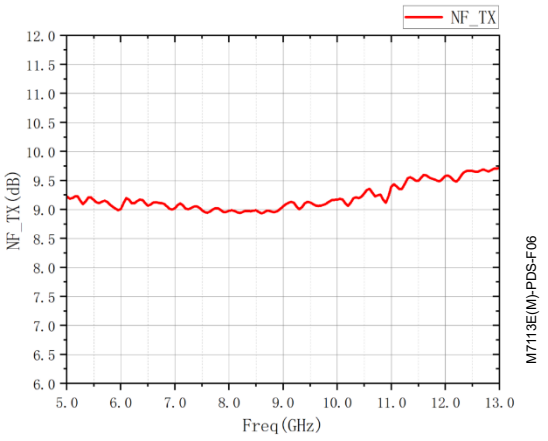


Figure 6. T_X NF Characteristics

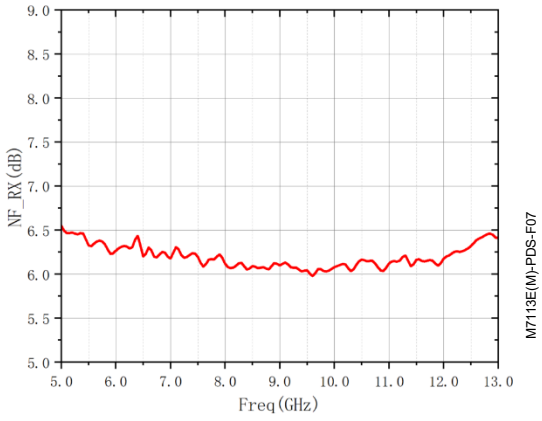


Figure 7. R_X NF Characteristics

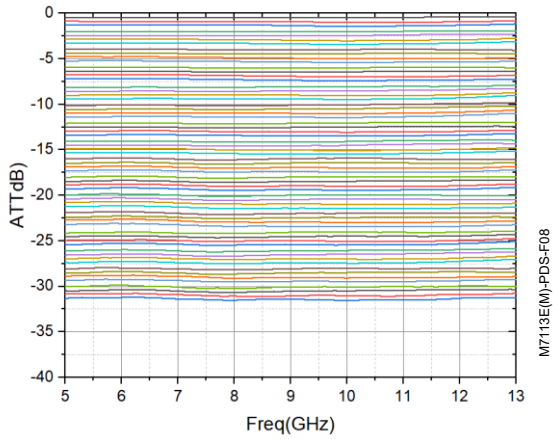


Figure 8. Full State Attenuation Characteristics

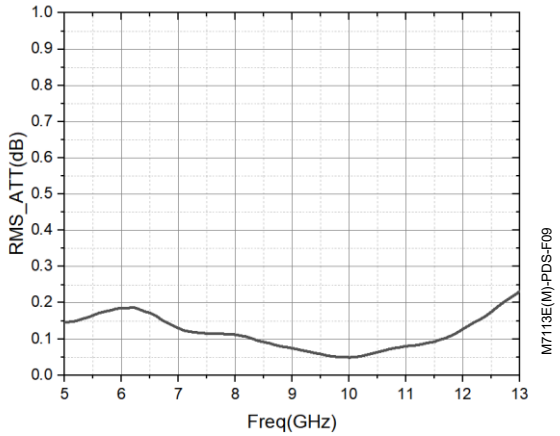


Figure 9. RMS Attenuation Error Characteristics

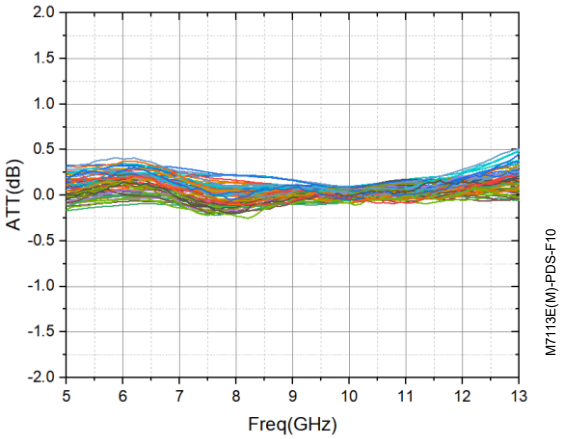


Figure 10. Full State Attenuation Error Characteristics

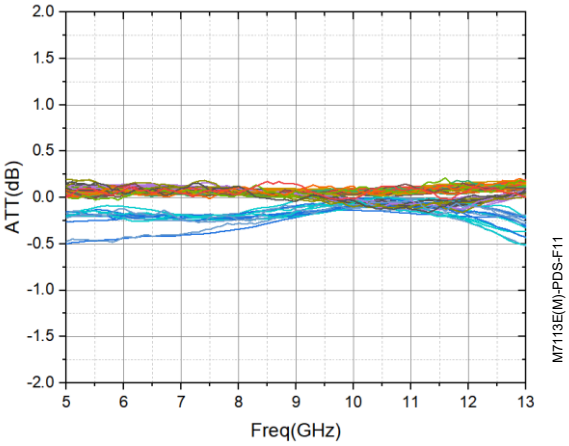


Figure 11. Adjacent State Attenuation Error Characteristics

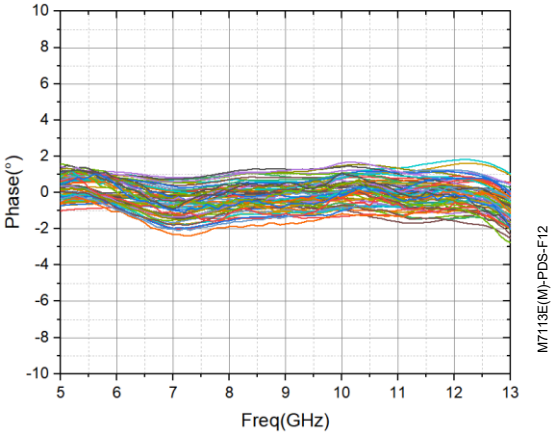


Figure 12. Full State Relative Phase Characteristics

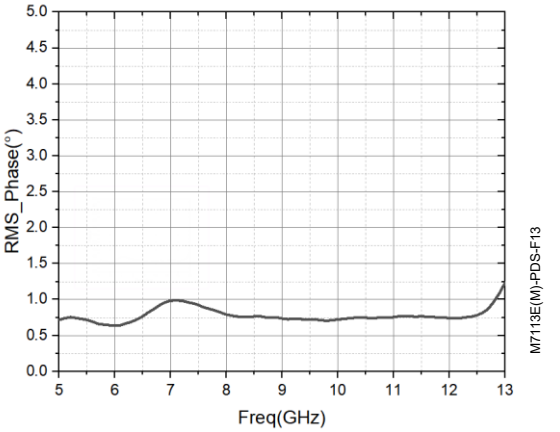


Figure 13. RMS Relative Phase Characteristics

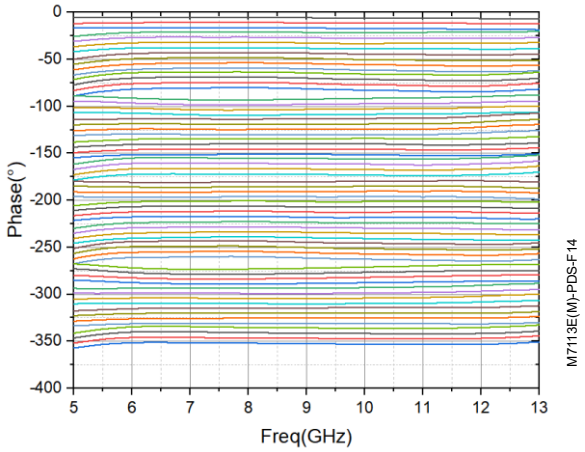


Figure 14. Full State Phase Shift Characteristics

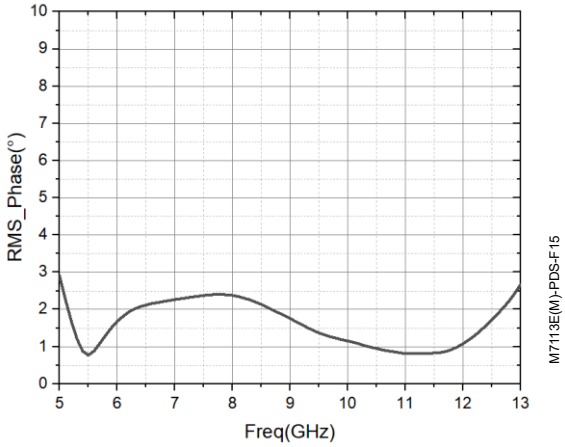


Figure 15. RMS Phase Error Characteristics

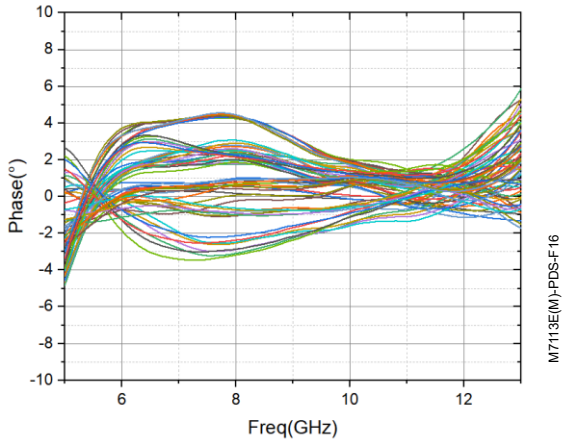


Figure 16. Full State Phase Error Characteristics

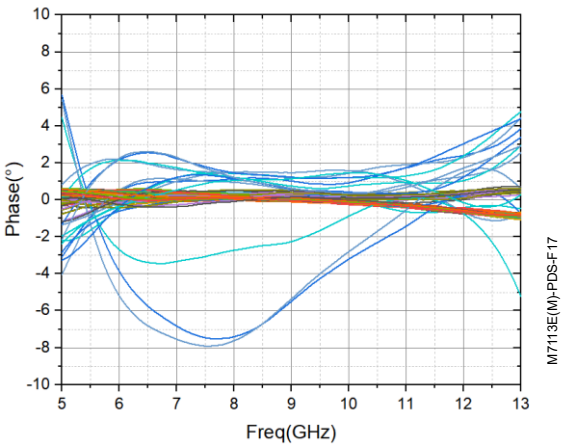


Figure 17. Adjacent State Phase Error Characteristics

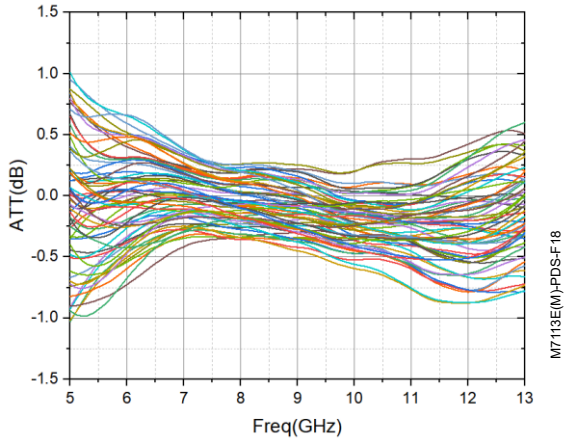


Figure 18. Full State Amplitude Error Characteristics

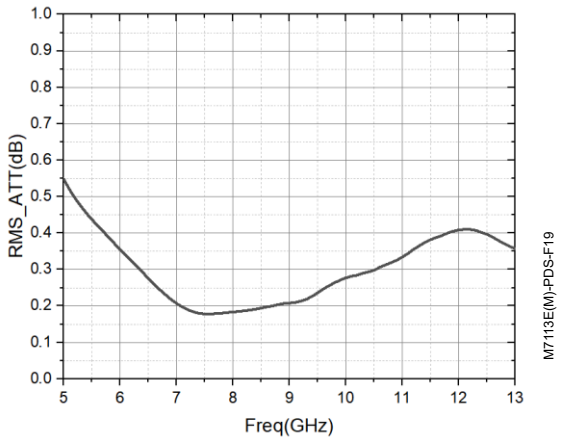


Figure 19. RMS Amplitude Error Characteristics

■ Power Characteristic Curve (25℃)

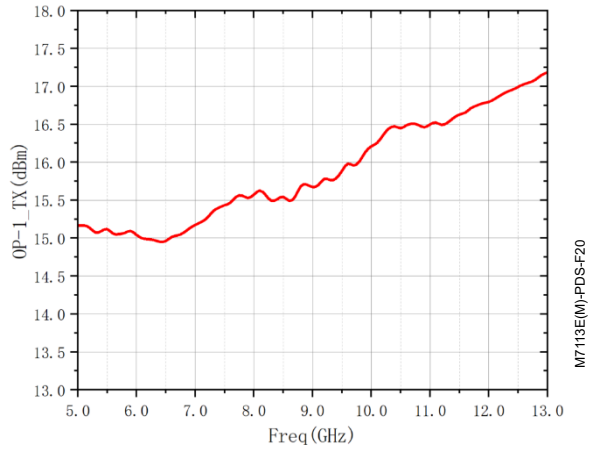


Figure 20. T_X OP-1dB Characteristics

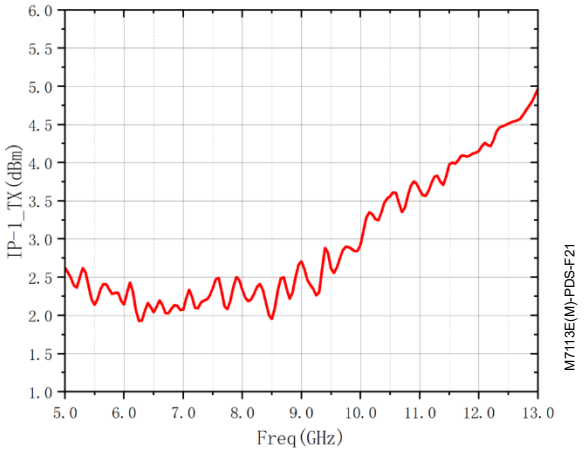


Figure 21. T_X IP-1dB Characteristics

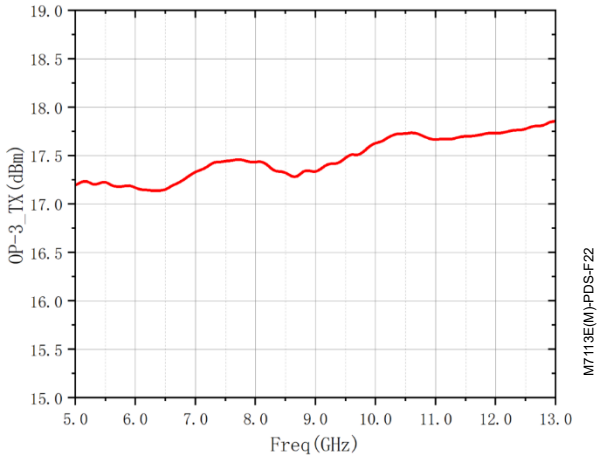


Figure 22. T_X OP-3dB Characteristics

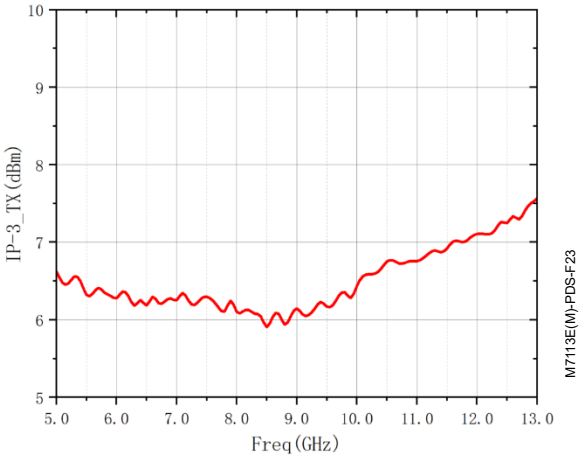


Figure 23. T_X IP-3dB Characteristics

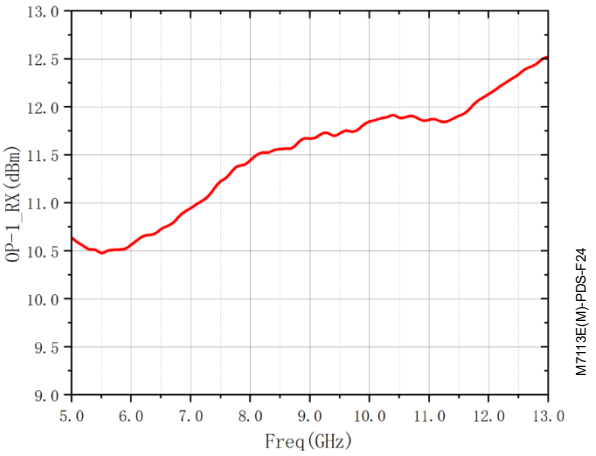


Figure 24. R_X OP-1dB Characteristics

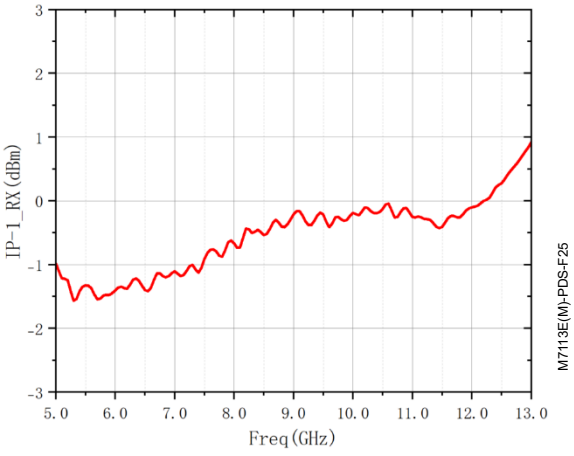


Figure 25. R_X IP-1dB Characteristics

■ Characteristic Curve vs Temperature

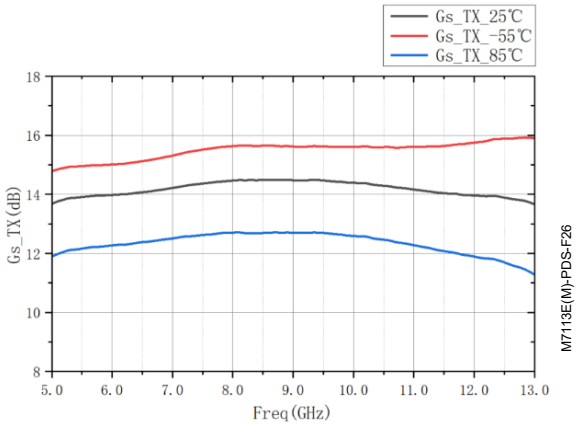


Figure 26. T_X Small-signal Gain vs Temperature

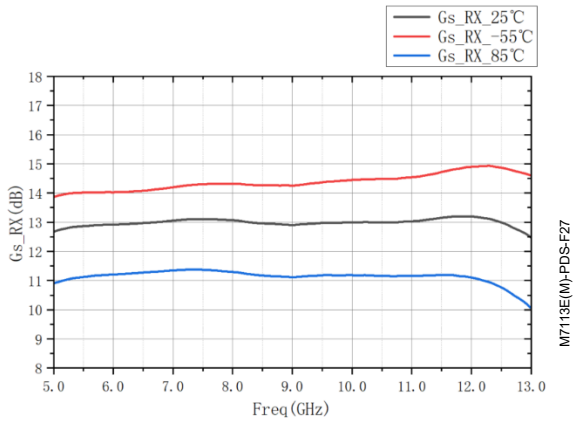


Figure 27. R_X Small-signal Gain vs Temperature

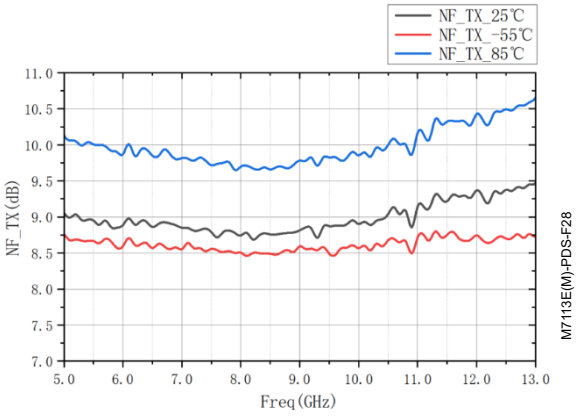


Figure 28. T_X NF Characteristics vs Temperature

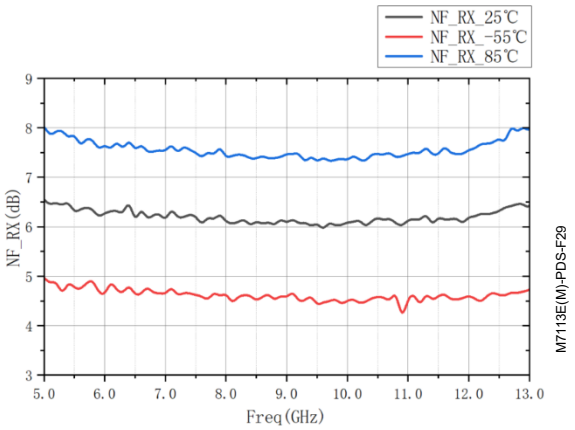


Figure 29. R_X NF Characteristics vs Temperature

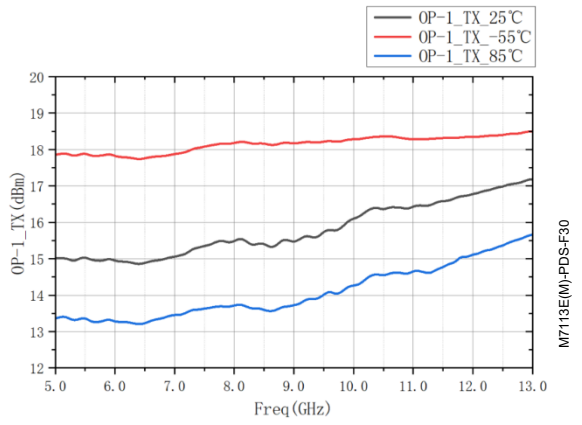


Figure 30. T_X OP_{-1dB} Characteristics vs Temperature

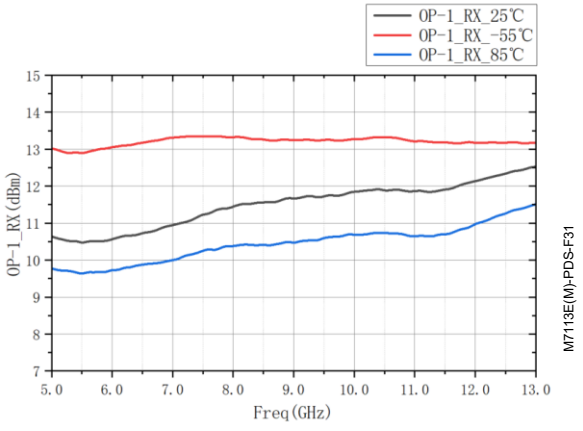
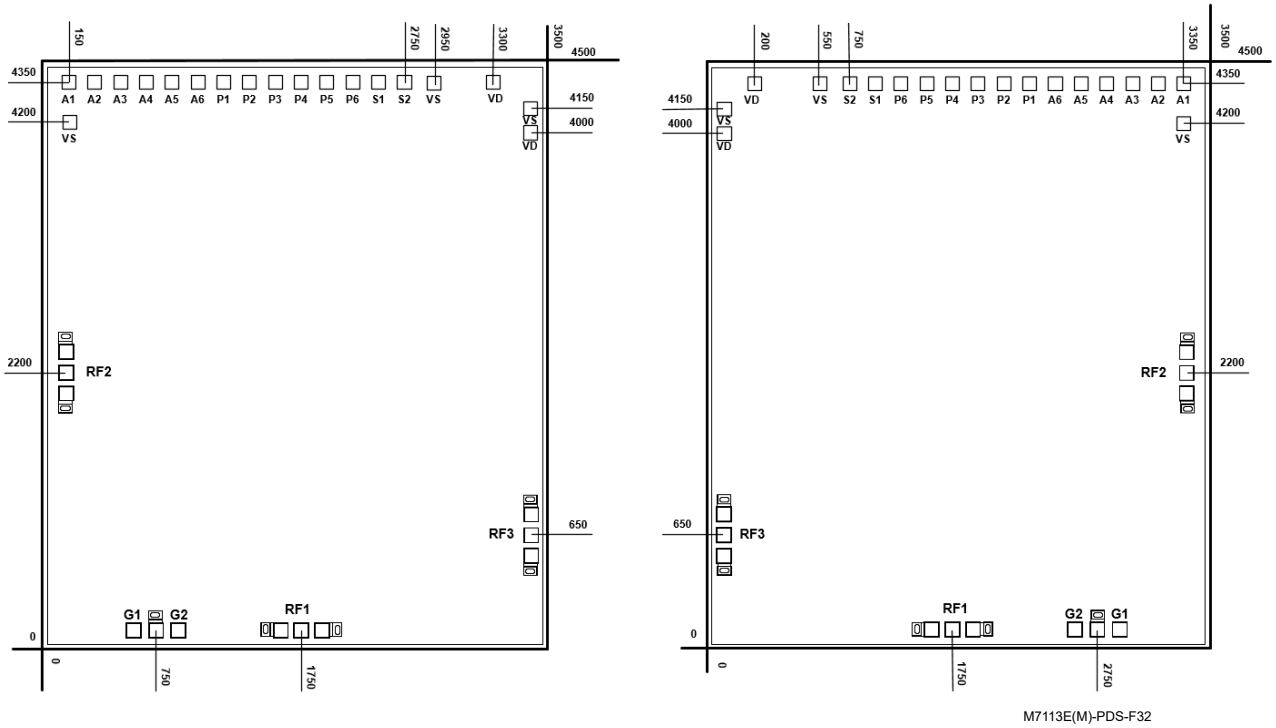


Figure 31. R_X OP_{-1dB} Characteristics vs Temperature

8. Outline Dimensions



- Dimensions shown in micrometre

Figure 32. M7113E(M) Outline Dimensions

Table 4. Pad Description

Pad	Symbol	Description
	RF1	T_X Input / R_X Output
	RF2	T_X Output
	RF3	R_X Input
	VS	Supply Voltage (Arbitrary pad can be selected)
	VD	RX /TX Supply Voltage (Arbitrary pad can be selected)
	S1	T_X / R_X / Load Control Voltage
	S2	T_X / R_X / Load Control Voltage
	A1-A6	6 Bit Attenuator Control Voltage
	P1-P6	6 Bit Phase-Shifter Control Voltage
	G1	Attenuation Bit 1dB, Enabled When Bond-wire to GND
	G2	Attenuation Bit 2dB, Enabled When Bond-wire to GND
	GND	Ground

Table 5. Truth Table[1]

5-1：Tx/Rx/Load Control Truth Table

	VD1	VD2	VS	S1	S2
TX RF1→RF2	5V	5V	-5V	1	1 or 0
RX RF3→RF1	5V	0V	-5V	0	1
Load	0V	0V	-5V	0	0

5-2：Attenuator Truth Table

	A1	A2	A3	A4	A5	A6
0dB	0	0	0	0	0	0
0.5dB	1	0	0	0	0	0
1dB	0	1	0	0	0	0
2dB	0	0	1	0	0	0
4dB	0	0	0	1	0	0
8dB	0	0	0	0	1	0
16dB	0	0	0	0	0	1

5-3：Phase-Shift Truth Table

	P1	P2	P3	P4	P5	P6
0°	0	0	0	0	0	0
5.625°	1	0	0	0	0	0
11.25°	0	1	0	0	0	0
22.5°	0	0	1	0	0	0
45°	0	0	0	1	0	0
90°	0	0	0	0	1	0
180°	0	0	0	0	0	1

[1] "0" for low voltage -0.5V~+0.5V, and "1" for high voltage +3V~+5.5V.

9. Assembly Information

■ Assembly Diagram

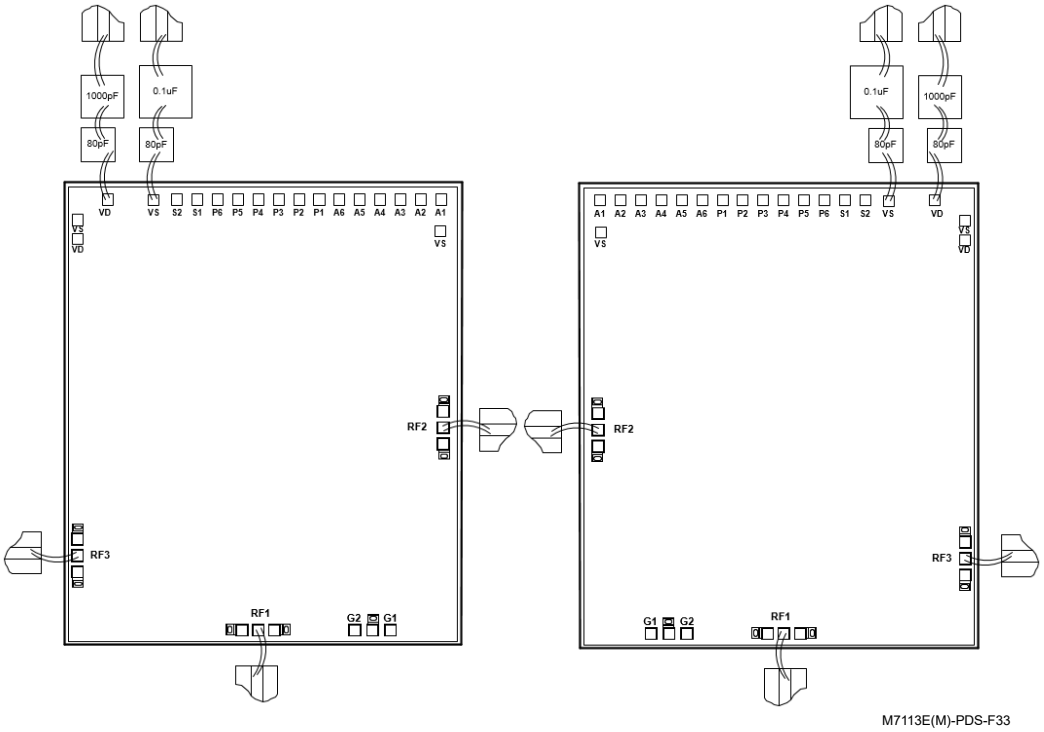


Figure 33. M7113E(M) Assembly Diagram

- **Eutectic Die Attach:** It is best to use an 80% Au/20% Sn preform. Do not expose the chip to a temperature greater than 300°C for more than 30sec.
- **Wire Bonding:** RF bonds made with 1mil gold wire are recommended for the RF ports. Keep all bonds as short as possible, less than 0.35mm.

10. Handling Precautions

■ Storage

All bare dies ship in either Waffle or Gel Pak, which is an ESD protective container, and then sealed in an ESD protective bag. After opening the sealed ESD protective bag, all dies must be stored in a dry nitrogen environment.

■ Cleanliness

Handle the dies in a clean environment. Never use liquid cleaning systems to clean the dies.

■ ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore proper ESD precautions should be taken to avoid performance degradation or loss of functionality.



11. Contact Information

For the latest specifications, additional product information, technical support and sales support, please contact:

- **Email:** RF.support@raytrontek.com
- **Web:** www.raytrontek.com

12. Disclaimer

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