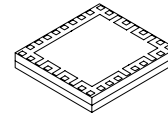


# MMM6025



**Package Information**

Case 1603-2  
9.85 × 9.0 × 1.4 mm HDI  
(Organic Multi-Chip Module)

**Ordering Information**

Device	Operating Temp. Range	Package
MMM6025	-20° to 70°C	HDI Module
MMM6025R2	-20° to 70°C	HDI Module Tape and Reel

# MMM6025

## Quad-Band GSM/GPRS Power Amplifier Front-End Module with PA and Antenna Switch

### 1 Introduction

The MMM6025 is a 50 Ω Tx Power Amplifier Front-End Module for quad- and tri-band GSM/GPRS handset applications, functioning over the GSM850, EGSM, DCS, and PCS transmit and receive frequency bands. It is compatible with GSM/GPRS Class 12 operating modes. To simplify radio front-end design requirements, power amplification, power coupling, power detection, low pass filtering, and antenna switching functions are integrated into the Power Amplifier Front-End Module. Transmit/receive path and enable functions are controlled through 0/2.8 V logic inputs.

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This document contains information on a new product. Specifications and information herein are subject to change without notice.

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## 2 Functional Block Diagram

Figure 1 is a functional block diagram of the quad-band (GSM850, EGSM, DCS, and PCS) power amplifier module.

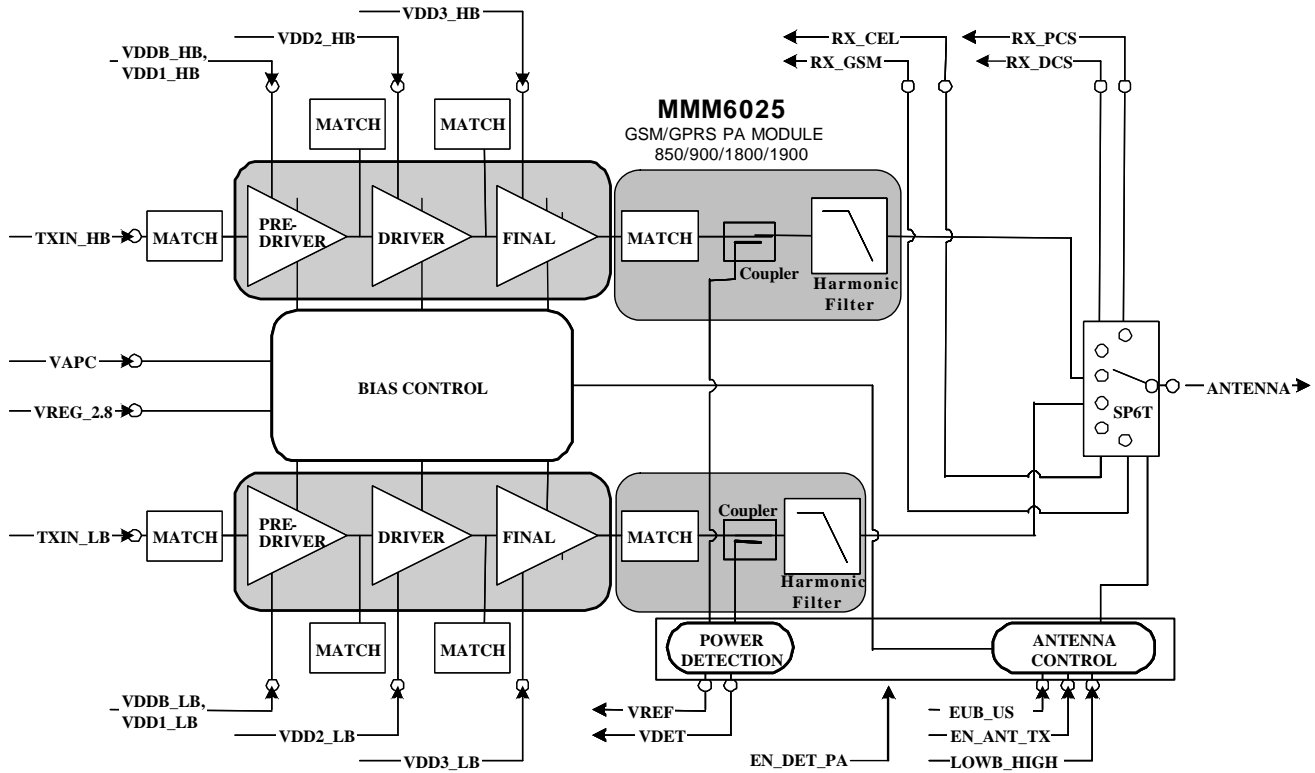


Figure 1. Functional Block Diagram

## 3 Electrical Characteristics

Table 1. Maximum Ratings

Rating	Symbol	Value	Unit
Drain Supply Voltages	V <sub>dd</sub>	7.0	V
RF Input Power	P <sub>in</sub>	11	dBm
Operating (Ambient) Temperature Range	T <sub>A</sub>	-20 to 70	°C
Storage Temperature	T <sub>stg</sub>	-40 to 125	°C
Junction Temperature	T <sub>J</sub>	125	°C

**Note:** Maximum Ratings and ESD

- Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the limits in the Electrical Characteristics or Recommended Operating Conditions tables.
- ESD (electrostatic discharge) immunity meets Human Body Model (HBM) ≤ 150 V and Machine Model (MM) ≤ 50 V. Additional ESD data available upon request.

**Table 2. Recommended Operating Conditions**

Characteristic	Symbol	Min	Typ	Max	Unit
Drain Supply Voltage	V <sub>dd</sub>	2.8	3.2	4.5	V
Power Control Ramp Voltage	V <sub>RAMP</sub>	0.1	-	2.2	V
RF Input Power	P <sub>in</sub>	5	-	11	dBm

**Table 3. DC Specifications**

Characteristic	Symbol	Min	Typ	Max	Unit
Voltage PA 1 (Drain Supplies)					V <sub>dc</sub>
Transmitter Off	V <sub>dd(TX_off)</sub>	-	3.6	7.0	
Transmitter On	V <sub>dd(TX_on)</sub>	2.8	3.2	4.5	
PA Output Control Voltage	V <sub>APC</sub>	0.1	0.2 to 2.1	2.2	V
PA Output Control Current	I <sub>APC</sub>	-3.0	-	3.5	mA
Detector PA Enable Voltage <sup>1</sup>					V <sub>dc</sub>
High	V <sub>EN_DET_PA(H)</sub>	2.5	-	2.9	
Low	V <sub>EN_DET_PA(L)</sub>	0	-	0.3	
Detector PA Enable Current <sup>1</sup>					mA μA
Source	I <sub>EN_DET_PA(H)</sub>	-	-	2.0	
Sink	I <sub>EN_DET_PA(L)</sub>	-	-	10	
Mode Select Voltage					V <sub>dc</sub>
US (selects GSM850 or PCS)	V <sub>EUB_US(H)</sub>	2.5	-	2.9	
EU (selects EGSM or DCS)	V <sub>EUB_US(L)</sub>	0	-	0.3	
RX Band Select Current					mA μA
Source	I <sub>EUB_US(H)</sub>	-	-	0.1	
Sink	I <sub>EUB_US(L)</sub>	-	-	10	
TX Antenna Enable Voltage					V <sub>dc</sub>
High	V <sub>EN_ANT_TX(H)</sub>	2.5	-	2.9	
Low	V <sub>EN_ANT_TX(L)</sub>	0	-	0.3	
TX Antenna Enable Current					mA μA
Source	I <sub>EN_ANT_TX(H)</sub>	-	-	0.1	
Sink	I <sub>EN_ANT_TX(L)</sub>	-	-	10	
Voltage PA 2 (Regulated Supply)	V <sub>REG28</sub>	2.65	-	2.9	V
Current Draw	I <sub>REG28</sub>	-	-	18	mA
BAND SELECT					V
High (DCS/PCS Bands Selected)	V <sub>LOWB_HIGH(H)</sub>	2.5	-	2.9	
Low (GSM850/EGSM Bands Selected)	V <sub>LOWB_HIGH(L)</sub>	0	-	0.3	

**Table 3. DC Specifications (continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
BAND SELECT Current Level					$\mu\text{A}$
High	$I_{\text{LOWB\_HIGH(H)}}$	-	-	10	
Low	$I_{\text{LOWB\_HIGH(L)}}$	-	-	10	
Total module leakage current (Standby condition) EN_DET_PA = 0.3 V EUB_US = EN_ANT_TX = +0.3 V LOWB_HIGH = 0.3 V $V_{\text{APC}} = 0.1 \text{ V}$ $V_{\text{REG\_IN}} = 0 \text{ V}$ or 2.775 V  Temp = 23 to 27°C Vdd = 3.8 V	$I_{\text{Vdd(off)}}$	-	5.0	7.0	$\mu\text{A}$

<sup>1</sup> The MMM6025 pinout is compatible with that of MMM6022, *except* pin 8.  
MMM6025 signal EN\_DET\_PA (pin 16) is equivalent to a combination of both MMM6022 signals EN\_TX and EN\_DET.

The following table provides additional details on MMM6025 orderable parts.

**Table 4. Orderable Parts Details**

Device	Operating Temp. Range (TA)	Package	RoHS Compliant	Pb-Free	MSLLevel	SolderTemp.
MMM6025	-20° to 70°C	HDI Module	Yes	Yes	3	250 °C
MMM6025R2	-20° to 70°C	HDI Module Tape and Reel	Yes	Yes	3	250 °C

## 4 RF Specifications

This section details specifications for the EGSM, DCS, GSM850, and PCS bands.

**Table 5. EGSM Band Specifications**

Characteristic	Symbol	Min	Typ	Max	Unit
<b>EGSM BAND</b> ( $P_{\text{in}} = 5.0$ to 11 dBm, $V_{\text{dd}} = 3.2 \text{ Vdc}$ , $V_{\text{APC}} = 0.1$ to 2.2 V pulsed, 25% duty cycle, LOWB_HIGH = Low, EUB_US = Low, $T_{\text{C}} = 25^\circ\text{C} \pm 5^\circ\text{C}$ , unless otherwise noted.)					
Operating Frequency	f				MHz
Transmit		880	-	915	
Receive		925	-	960	
Power Out	$P_{\text{o(max)}}$	33	-	-	dBm
Power Out Low Voltage ( $V_{\text{dd}} = 2.8 \text{ V}$ )	$P_{\text{o(min)}}$	32	-	-	dBm
Power Added Efficiency (Saturated $P_{\text{out}}$ )	PAE	40	44	-	%
Power Control Range <sup>1</sup>	$P_{\text{o(range)}}$	35	-	-	dB
Power Control Slope <sup>2</sup>	$\Delta V_{\text{det}}/\Delta V_{\text{APC}}$	-	-	3.0	V/V

Table 5. EGSM Band Specifications (continued)

Characteristic	Symbol	Min	Typ	Max	Unit
Power Control Frequency 3.0 dB BW	PC3dB	1.0	-	-	MHz
Power Control Response Time <sup>3</sup>	t <sub>PC</sub>	-	-	1.5	μs
Forward Isolation <sup>4</sup>	ISO1 ISO2	- -	- -	-41 -22	dBm
Power Detector Voltage <sup>1</sup> Low Power High Power	V <sub>DET(low)</sub> V <sub>DET(high)</sub>	40 1.0	- -	150 2.05	mV V
Harmonics <sup>5</sup> (P <sub>out</sub> Max = 33 dBm)	2f <sub>0</sub> - 15f <sub>0</sub>	-	-	-33	dBm
GSM RX Band Noise <sup>5</sup> (V <sub>dd</sub> = 4.2 V, Saturated P <sub>out</sub> ) (P <sub>out</sub> = 33 dBm)	n <sub>RX</sub> (925 to 935 MHz)	-	-	-73	dBm/ 100 kHz
	n <sub>RX</sub> (935 to 960 MHz)	-	-	-84	dBm/ 100 kHz
P <sub>out</sub> over Temp (V <sub>dd</sub> = 2.8 V, T <sub>A</sub> = -20 to 70°C)	P <sub>out(min)</sub>	31.5	-	-	dBm
Insertion Loss from Antenna to RX_GSM <sup>5</sup>	IL_RX	-	-	1.4	dB
Tx - Rx Isolation <sup>5</sup> ANTENNA to RX_CEL ANTENNA to RX_GSM ANTENNA to RX_DCS ANTENNA to RX_PCS	ISO_ANT_RX_CEL	27	-	-	dB
	ISO_ANT_RX_GSM	27	-	-	
	ISO_ANT_RX_DCS	27	-	-	
	ISO_ANT_RX_PCS	27	-	-	
Input VSWR	VSWR	-	-	2:1	
Power Out Change due to Coupling Variations (VSWR = 3:1 @ ANT Port) <sup>6</sup>	CPLV	-1.5	-	1.5	dB
Load Mismatch Stress (Ruggedness) <sup>7</sup>	Rugg	No performance degradation and no module damage			
Stability - Spurious Output <sup>8</sup>	Stab	-	-	-36	dBm
Closed Loop Power Variation over Temperature <sup>9</sup>	P <sub>out_Temp</sub> Ambient 1 (P <sub>out</sub> = 6 dBm)	-1.5	-	1.5	dB
	P <sub>out_Temp</sub> Ambient 2 (P <sub>out</sub> = 20 dBm)	1.0	-	1.0	dB
	P <sub>out_Temp</sub> Ambient 3 (P <sub>out</sub> = 33 dBm)	-0.5	-	0.5	dB

<sup>1</sup> Power output must be monotonic with power detector voltage. (V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C)

<sup>2</sup> V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C

<sup>3</sup> Measurement made from 50% of V<sub>APC</sub> to 10%/90% of V<sub>DET\_OUT</sub> final value, with pulsed V<sub>APC</sub> with a peak voltage in the range of 0.1 to 2.2 V and both rise and fall edges.

<sup>4</sup> Measured at antenna port, ISO1: P<sub>in</sub> = -10 dBm, EN\_ANT\_TX = 0 V, V<sub>APC</sub> = 0.1 V;  
ISO2: P<sub>in</sub> = 11 dBm, EN\_ANT\_TX = 2.723 V, V<sub>APC</sub> = 0.1 V. (V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C)

<sup>5</sup> V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C

<sup>6</sup> Maintaining constant V<sub>det</sub>-V<sub>ref</sub> at all mismatch phase angles. Measured at antenna port: P<sub>out</sub> = 33 dBm

<sup>7</sup> Output VSWR = 20:1 all phase angles, V<sub>dd</sub> = 2.8V to 4.5V, P<sub>in</sub> = 5dBm to 11dBm, Temperature = -20 to +70°C, Power less than or equal to 33dBm.

## RF Specifications

- <sup>8</sup> Output VSWR = 10:1 all phase angles, Vdd = 2.8V to 4.5V, Pin = 5dBm to 11dBm, Temperature = -20 to +70°C, Power less than or equal to 33dBm.
- <sup>9</sup>  $V_{diff\_var} = 20 \cdot \text{LOG}(\Delta(T)/\Delta(25^\circ\text{C}))$ , where T is -20 to 65°C,  $\Delta(T) = [V_{diff}(T) \text{ with RF}] - [V_{diff}(T) \text{ without RF}]$ , and  $\Delta(25^\circ\text{C}) = [V_{diff}(25^\circ\text{C}) \text{ with RF}] - [V_{diff}(25^\circ\text{C}) \text{ without RF}]$

**Table 6. DCS Band Specifications**

Characteristic	Symbol	Min	Typ	Max	Unit
<b>DCS BAND</b> ( $P_{in} = 5.0$ to $11$ dBm, $V_{dd} = 3.2$ Vdc, $V_{APC} = 0.1$ to $2.2$ V pulsed, 25% duty cycle, LOWB_HIGH = High, EUB_US = Low, $T_C = 25^\circ\text{C} \pm 5^\circ\text{C}$ , unless otherwise noted.)					
Operating Frequency Transmit Receive	f	1710 1805	- -	1785 1880	MHz
Power Out	$P_{o(max)}$	30	-	-	dBm
Power Out Low Voltage ( $V_{dd} = 2.8$ V)	$P_{o(min)}$	29	-	-	dBm
Power Added Efficiency (Saturated $P_{out}$ )	PAE	28	33	-	%
Power Control Range <sup>1</sup>	$P_{o(range)}$	35	-	-	dB
Power Control Slope <sup>2</sup>	$\Delta V_{det}/\Delta V_{APC}$	-	-	3.5	V/V
Power Control Frequency 3.0 dB BW	PC3dB	1.0	-	-	MHz
Power Control Response Time <sup>3</sup>	$t_{PC}$	-	-	1.5	$\mu\text{s}$
Forward Isolation <sup>4</sup>	ISO1 ISO2	- -	- -	-53 -25	dBm
Power Detector Voltage <sup>1</sup> Low Power High Power	VDET(low) VDET(high)	40 1.0	- -	150 2.05	mV V
Harmonics <sup>6</sup> ( $P_{out}$ Max = 30 dBm)	$2f_0 - 15f_0$	-	-	-33	dBm
RX Band Noise <sup>5,6</sup> ( $P_{out} = 30$ dBm)	$\eta_{RX}$	-	-	-77	dBm/ 100 kHz
$P_{out}$ over Temp ( $V_{dd} = 2.8$ V, $T_A = -20$ to $70^\circ\text{C}$ )	$P_{o\_ot(min)}$	28.5	-	-	dBm
Insertion Loss from Antenna to RX_DCS <sup>6</sup>	IL_RX	-	-	1.7	dB
Tx - Rx Isolation <sup>6</sup> ANTENNA to RX_CEL ANTENNA to RX_GSM ANTENNA to RX_DCS ANTENNA to RX_PCS	ISO_ANT_RX_CEL ISO_ANT_RX_GSM ISO_ANT_RX_DCS ISO_ANT_RX_PCS	27 27 27 27	- - - -	- - - -	dB
Input VSWR	VSWR	-	-	2:1	
Power Out Change due to Coupling Variations (VSWR = 3:1 @ ANT Port) <sup>7</sup>	CPLV	-1.5	-	1.5	dB
Load Mismatch Stress (Ruggedness) <sup>8</sup>	Rugg	No performance degradation and no module damage			

**Table 6. DCS Band Specifications (continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Stability - Spurious Output <sup>9</sup>	Stab	-	-	-36	dBm
Closed Loop Power Variation over Temperature <sup>10</sup>	P <sub>out</sub> _Temp Ambient 1 (P <sub>out</sub> = 3 dBm)	-1.5	-	1.5	dB
	P <sub>out</sub> _Temp Ambient 2 (P <sub>out</sub> = 15 dBm)	1.0	-	1.0	dB
	P <sub>out</sub> _Temp Ambient 3 (P <sub>out</sub> = 30 dBm)	-0.5	-	0.5	dB

<sup>1</sup> Power output must be monotonic with power detector voltage. (V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C)

<sup>2</sup> V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C

<sup>3</sup> Measurement made from 50% of V<sub>APC</sub> to 10%/90% of V<sub>DET\_OUT</sub> final value, with pulsed V<sub>APC</sub> with a peak voltage in the range of 0.1 to 2.2 V and both rise and fall edges.

<sup>4</sup> Measured at antenna port: ISO1: P<sub>in</sub> = -10 dBm, EN\_ANT\_TX = 0 V, V<sub>APC</sub> = 0.1 V;

ISO2: P<sub>in</sub> = 11 dBm, EN\_ANT\_TX = 2.723 V, V<sub>APC</sub> = 0.1 V. (V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C)

<sup>5</sup> DCS RX band = 1805 to 1880 MHz. V<sub>dd</sub> = 4.2V, Saturated P<sub>out</sub>.

<sup>6</sup> V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C

<sup>7</sup> Maintaining constant V<sub>det</sub>-V<sub>ref</sub> at all mismatch phase angles. Measured at antenna port: P<sub>out</sub> = 30 dBm

<sup>8</sup> VSWR = 20:1 all phase angles, V<sub>dd</sub> = 2.8V to 4.5V, P<sub>in</sub> = 5dBm to 11dBm, Temperature = -20 to +70°C, Power less than or equal to 30 dBm

<sup>9</sup> Output VSWR = 10:1 all phase angles, V<sub>dd</sub> = 2.8V to 4.5V, P<sub>in</sub> = 5dBm to 11dBm, Temperature = -20 to +70°C, Power less than or equal to 30dBm.

<sup>10</sup> V<sub>diff\_var</sub> = 20\*LOG(Delta(T)/Delta(25°C)), where T is -20 to 65°C, Delta(T) = [V<sub>diff</sub>(T) with RF] - [V<sub>diff</sub>(T) without RF], and Delta(25°C) = [V<sub>diff</sub>(25°C) with RF] - [V<sub>diff</sub>(25°C) without RF]

**Table 7. GSM850 Band Specifications**

Characteristic	Symbol	Min	Typ	Max	Unit
<b>GSM850 BAND</b> (P <sub>in</sub> = 5.0 to 11 dBm, V <sub>dd</sub> = 3.2 Vdc, V <sub>APC</sub> = 0.1 to 2.2 V pulsed, 25% duty cycle, LOWB_HIGH = Low, EUB_US = High, T <sub>C</sub> = 25°C ±5°C, unless otherwise noted.)					
Operating Frequency Transmit Receive	f	824 869	- -	849 894	MHz
Power Out	P <sub>o(max)</sub>	33	-	-	dBm
Power Out Low Voltage (V <sub>CC_PA</sub> = 2.8 V)	P <sub>o(min)</sub>	32	-	-	dBm
Power Added Efficiency (Saturated P <sub>out</sub> )	PAE	38	43	-	%
Power Control Range <sup>1</sup>	P <sub>o(range)</sub>	35	-	-	dB
Power Control Slope <sup>2</sup>	ΔV <sub>det</sub> /ΔV <sub>APC</sub>	-	-	3.0	V/V
Power Control Frequency 3.0 dB BW	PC3dB	1.0	-	-	MHz
Power Control Response Time <sup>3</sup>	t <sub>PC</sub>	-	-	1.5	μs
Forward Isolation <sup>4</sup>	ISO1	-	-	-41	dBm
	ISO2	-	-	-22	dBm

**Table 7. GSM850 Band Specifications (continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Power Detector Voltage <sup>1</sup> Low Power High Power	VDET(low) VDET(high)	40 1.0	- -	150 2.05	mV V
Harmonics <sup>6</sup> (P <sub>out</sub> Max = 33 dBm)	2f <sub>0</sub> - 15f <sub>0</sub>	-	-	-33	dBm
GSM850 RX Band Noise <sup>5,6</sup> (P <sub>out</sub> = 33 dBm)	η <sub>RX</sub>	-	-	-84	dBm/ 100 kHz
P <sub>out</sub> over Temp (V <sub>dd</sub> = 2.8 V, T <sub>A</sub> = -20 to 70°C)	P <sub>o_ot(min)</sub>	31.5	-	-	dBm
Insertion Loss from Antenna to RX_GSM850 <sup>6</sup>	IL_RX	-	-	1.4	dB
Tx - Rx Isolation <sup>6</sup> ANTENNA to RX_CEL ANTENNA to RX_GSM ANTENNA to RX_DCS ANTENNA to RX_PCS	ISO_ANT_RX_CEL ISO_ANT_RX_GSM ISO_ANT_RX_DCS ISO_ANT_RX_PCS	27 27 27 27	- - - -	- - - -	dB
Input VSWR	VSWR	-	-	2:1	
Power Out Change due to Coupling Variations (VSWR = 3:1 @ ANT Port) <sup>7</sup>	CPLV	-1.5	-	1.5	dB
Load Mismatch Stress (Ruggedness) <sup>8</sup>	Rugg	No performance degradation and no module damage			
Stability - Spurious Output <sup>9</sup>	Stab	-	-	-36	dBm
Closed Loop Power Variation over Temperature <sup>10</sup>	P <sub>out_Temp Ambient 1</sub> P <sub>out</sub> = 6 dBm P <sub>out_Temp Ambient 2</sub> P <sub>out</sub> = 20 dBm P <sub>out_Temp Ambient 3</sub> P <sub>out</sub> = 33 dBm	-1.5 dB 1.0 dB -0.5 dB	- - -	1.5dB 1.0 dB 0.5 dB	dB dB dB

<sup>1</sup> Power output must be monotonic with power detector voltage. (V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C)

<sup>2</sup> V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C

<sup>3</sup> Measurement made from 50% of V<sub>APC</sub> to 10%/90% of V<sub>DET\_OUT</sub> final value, with pulsed V<sub>APC</sub> with a peak voltage in the range of 0.1 to 2.2 V and both rise and fall edges.

<sup>4</sup> Measured at antenna port: ISO1: P<sub>in</sub> = -10 dBm, EN\_ANT\_TX = 0 V, V<sub>APC</sub> = 0.1 V;  
ISO2: P<sub>in</sub> = 11 dBm, EN\_ANT\_TX = 2.723 V, V<sub>APC</sub> = 0.1 V. (V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C)

<sup>5</sup> GSM850 RX band = 869 to 894 MHz. V<sub>dd</sub> = 4.2 V, Saturated P<sub>out</sub>.

<sup>6</sup> V<sub>dd</sub> = 2.8V to 4.5V and Temperature = -20 to +70°C

<sup>7</sup> Maintaining constant V<sub>det</sub>-V<sub>ref</sub> at all mismatch phase angles. Measured at antenna port: P<sub>out</sub> = 33 dBm

<sup>8</sup> VSWR = 20:1 all phase angles, V<sub>dd</sub> = 2.8V to 4.5V, P<sub>in</sub> = 5dBm to 11dBm, Temperature = -20 to +70°C, Power less than or equal to 33dBm

<sup>9</sup> Output VSWR = 10:1 all phase angles, V<sub>dd</sub> = 2.8V to 4.5V, P<sub>in</sub> = 5dBm to 11dBm, Temperature = -20 to +70°C, Power less than or equal to 33dBm.

<sup>10</sup> V<sub>diff\_var</sub> = 20\*LOG(Delta(T)/Delta(25°C)), where T is -20 to 65°C, Delta(T) = [V<sub>diff</sub>(T) with RF] - [V<sub>diff</sub>(T) without RF], and Delta(25°C) = [V<sub>diff</sub>(25°C) with RF] - [V<sub>diff</sub>(25°C) without RF]



Table 8. PCS Band Specifications

Characteristic	Symbol	Min	Typ	Max	Unit
<b>PCS BAND</b> ( $P_{in} = 5.0$ to $11$ dBm, $V_{dd} = 3.2$ Vdc, $V_{APC} = 0.1$ to $2.2$ V pulsed, 25% duty cycle, LOWB_HIGH = High, EUB_US = High, $T_C = 25^\circ\text{C} \pm 5^\circ\text{C}$ , unless otherwise noted.)					
Operating Frequency Transmit Receive	f	1850 1930	- -	1910 1990	MHz
Power Out	$P_{o(max)}$	30	-	-	dBm
Power Out Low Voltage ( $V_{dd} = 2.8$ V)	$P_{o(min)}$	29	-	-	dBm
Power Added Efficiency (Saturated $P_{out}$ )	PAE	28	33	-	%
Power Control Range <sup>1</sup>	$P_{o(range)}$	35	-	-	dB
Power Control Slope <sup>2</sup>	$\Delta V_{det}/\Delta V_{APC}$	-	-	3.5	V/V
Power Control Frequency 3.0 dB BW	PC3dB	1.0	-	-	MHz
Power Control Response Time <sup>3</sup>	$t_{PC}$	-	-	1.5	$\mu\text{s}$
Forward Isolation <sup>4</sup>	ISO1 ISO2	- -	- -	-53 -25	dBm
Power Detector Voltage <sup>1</sup> Low Power High Power	VDET(low) VDET(high)	40 1.0	- -	150 2.05	mV V
Harmonics <sup>6</sup> ( $P_{out}$ Max = 30 dBm)	$2f_0 - 15f_0$	-	-	-33	dBm
RX Band Noise <sup>5,6</sup> ( $P_{out} = 30$ dBm)	$\eta_{RX}$	-	-	-77	dBm/100 kHz
$P_{out}$ over Temp ( $V_{dd} = 2.8$ V, $T_A = -20$ to $70^\circ\text{C}$ )	$P_{o_{ot}(min)}$	28.5	-	-	dBm
Insertion Loss from Antenna to RX_PCS <sup>6</sup>	IL_RX	-	-	1.7	dB
Tx - Rx Isolation <sup>6</sup> ANT to RX_CEL ANT to RX_GSM ANT to RX_DCS ANT to RX_PCS	ISO_ANT_RX_CEL ISO_ANT_RX_GSM ISO_ANT_RX_DCS ISO_ANT_RX_PCS	27 27 27 27	- - - -	- - - -	dB
Input VSWR	VSWR	-	-	2:1	
Power Out Change due to Coupling Variations (VSWR = 3:1 @ ANT Port) <sup>7</sup>	CPLV	-1.5	-	1.5	dB
Load Mismatch Stress (Ruggedness) <sup>8</sup>	Rugg	No performance degradation or module damage			

**Table 8. PCS Band Specifications (continued)**

Characteristic	Symbol	Min	Typ	Max	Unit
Stability - Spurious Output <sup>9</sup>	Stab	-	-	-36	dBm
Closed Loop Power Variation over Temperature <sup>10</sup>	$P_{out\_Temp\ Ambient}$ 1 $P_{out} = 3\ dBm$	-1.5 dB	-	1.5dB	dB
	$P_{out\_Temp\ Ambient}$ 2 $P_{out} = 15\ dBm$	1.0 dB	-	1.0 dB	dB
	$P_{out\_Temp\ Ambient}$ 3 $P_{out} = 30\ dBm$	dB	-	0.5 dB	dB
		-0.5 dB			

<sup>1</sup> Power output must be monotonic with power detector voltage. (Vdd = 2.8V to 4.5V and Temperature = -20 to +70 °C)

<sup>2</sup> Vdd = 2.8V to 4.5V and Temperature = -20 to +70 °C

<sup>3</sup> Measurement made from 50% of  $V_{APC}$  to 10%/90% of  $V_{DET\_OUT}$  final value, with pulsed  $V_{APC}$  with a peak voltage in the range of 0.1 to 2.2 V and both rise and fall edges.

<sup>4</sup> Measured at antenna port, ISO1:  $P_{in} = -10\ dBm$ ,  $EN\_ANT\_TX = 0\ V$ ,  $V_{APC} = 0.1\ V$ ;  
ISO2:  $P_{in} = 11\ dBm$ ,  $EN\_ANT\_TX = 2.723\ V$ ,  $V_{APC} = 0.1$ . (Vdd = 2.8V to 4.5V and Temperature = -20 to +70 °C)

<sup>5</sup> PCS RX band = 1930 to 1990 MHz. Vdd = 4.2 V, Saturated  $P_{out}$ .

<sup>6</sup> Vdd = 2.8V to 4.5V and Temperature = -20 to +70 °C

<sup>7</sup> Maintaining constant Vdet-Vref at all mismatch phase angles. Measured at antenna port:  $P_{out} = 30\ dBm$

<sup>8</sup> VSWR = 20:1 all phase angles, Vdd = 2.8V to 4.5V,  $P_{in} = 5\ dBm$  to 11dBm, Temperature = -20 to +70°C, Power less than or equal to 30 dBm

<sup>9</sup> Output VSWR = 10:1 all phase angles, Vdd = 2.8V to 4.5V,  $P_{in} = 5\ dBm$  to 11dBm, Temperature = -20 to +70°C, Power less than or equal to 30dBm.

<sup>10</sup>  $V_{diff\_var} = 20 * \text{LOG}(\Delta(T)/\Delta(25^\circ\text{C}))$ , where T is -20 to 65°C,  $\Delta(T) = [V_{diff}(T) \text{ with RF}] - [V_{diff}(T) \text{ without RF}]$ , and  $\Delta(25^\circ\text{C}) = [V_{diff}(25^\circ\text{C}) \text{ with RF}] - [V_{diff}(25^\circ\text{C}) \text{ without RF}]$

# 5 Signal Descriptions

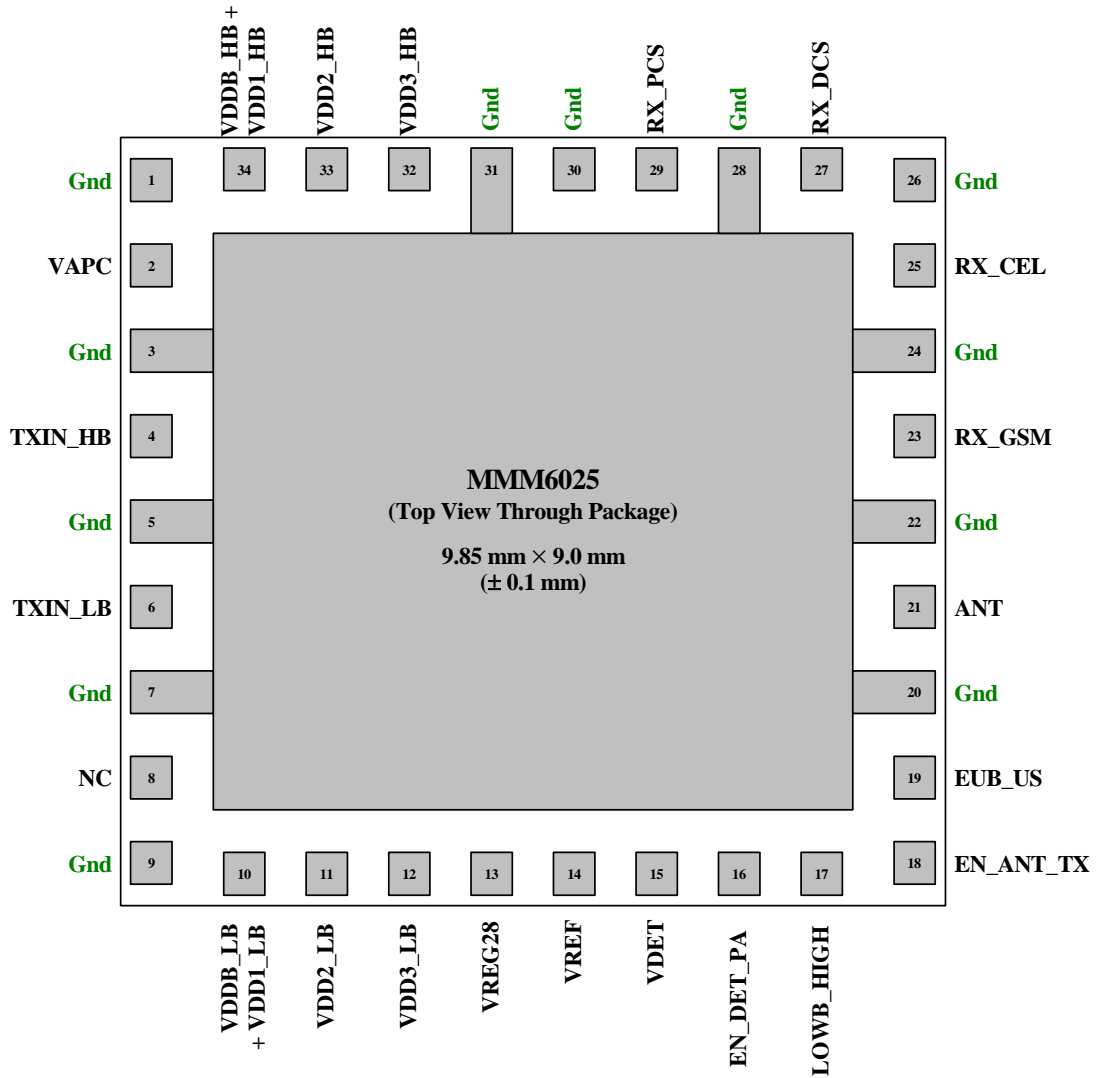


Figure 2. Pin Out

Table 9. Contact Connections

Section	Signal	Description	Pin(s)
RF	TXIN_LB	TX Input (Low Bands), DC Blocked	6
	TXIN_HB	TX Input (High Bands), DC Blocked	4
	ANT	Antenna	21
	RX_GSM	RX Output (GSM Band)	23
	RX_DCS	RX Output (DCS Band)	27
	RX_CEL	RX Output (CEL Band)	25
	RX_PCS	RX Output (PCS Band)	29

**Table 9. Contact Connections (continued)**

Section	Signal	Description	Pin(s)
Supply	VDDB_LB	DC Supply (Battery) for Bias Control (Low Bands)	10
	VDD1_LB	DC Supply (Battery) for Pre-Driver (Low Bands)	
	VDD2_LB	DC Supply (Battery) for Driver Stage (Low Bands)	11
	VDD3_LB	DC Supply (Battery) for Final Stage (Low Bands)	12
	VDDB_HB	DC Supply (Battery) for Bias Control (High Bands)	34
	VDD1_HB	DC Supply (Battery) for Pre-Driver (High Bands)	
	VDD2_HB	DC Supply (Battery) for Driver Stage (High Bands)	33
	VDD3_HB	DC Supply (Battery) for Final Stage (High Bands)	32
	VREG28	DC Reference Supply (Regulated)	13
Control	VAPC	Analog Power Control	2
	LOWB_HIGH	Band Select Low (CEL, GSM)/High (DCS,PCS)	17
	EN_ANT_TX	Enable TX Antenna Switch Path	18
	EUB_US	Mode Select EU (GSM, DCS)/US (CEL, PCS)	19
	EN_DET_PA	Enable Detector and Power Amplifier <sup>1</sup>	16
Power Detection	VDET	Detected Output of Detector	15
	VREF	Reference Output of Detector	14
Ground	Gnd	Ground	3, 5, 7, 20, 22, 24, 26, 28, 31, 1, 9, 30

<sup>1</sup> The MMM6025 pinout is compatible with that of MMM6022, *except* pin 8. MMM6025 signal EN\_DET\_PA (pin 16) is equivalent to a combination of both MMM6022 signals EN\_TX and EN\_DET.

**Table 10. Logic States**

EUB_US	LOWB_HIGH	EN_AN_TX	Mode	Band(s)
High	Low	High	TX	GSM850
Low	Low	High	TX	EGSM
Low	High	High	TX	DCS
High	High	High	TX	PCS
High	Low	Low	RX	GSM850
Low	Low	Low	RX	EGSM
Low	High	Low	RX	DCS
High	High	Low	RX	PCS

Figure 3 shows the top view of the MMM6025 demoboard application schematic.

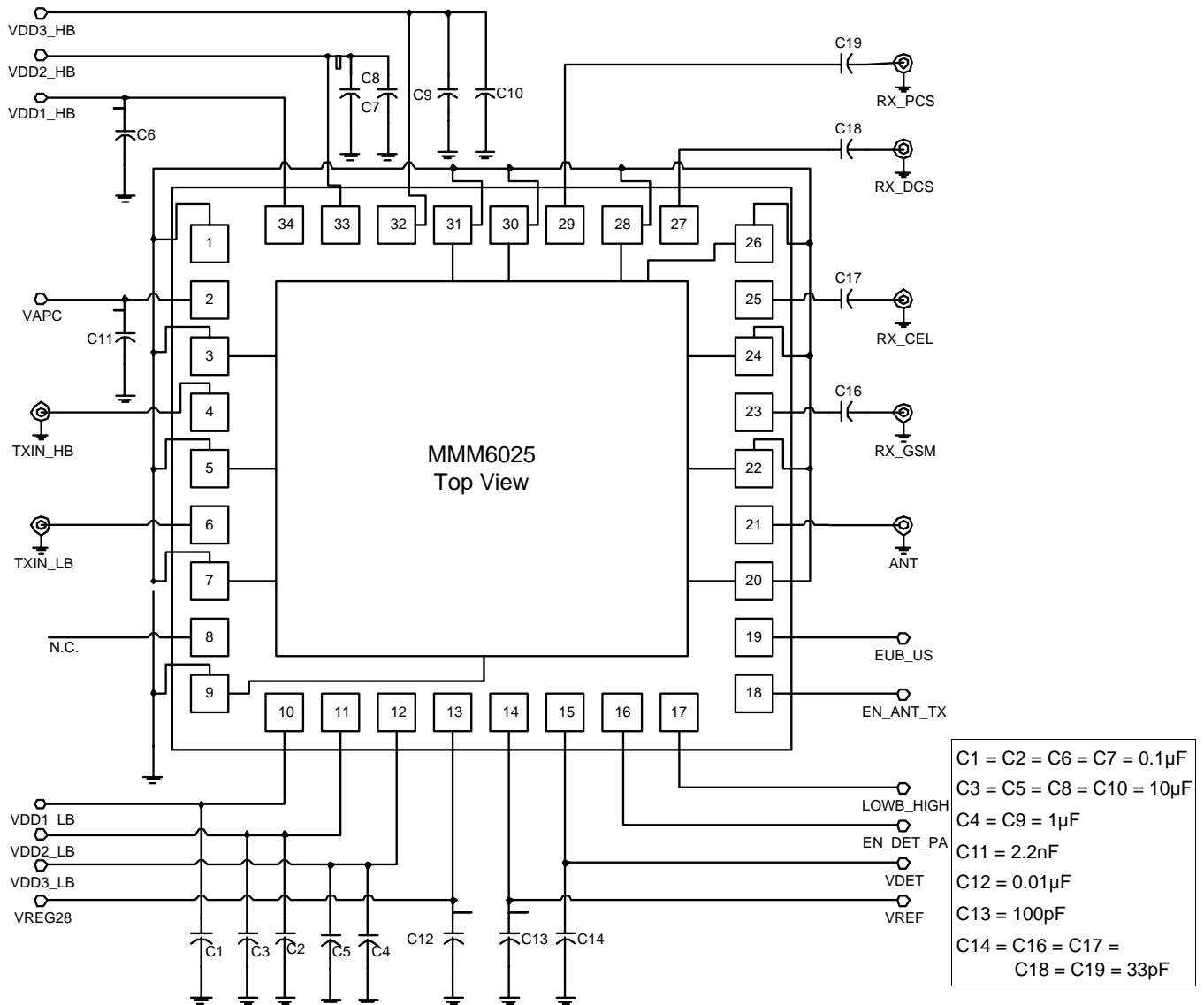


Figure 3. Demoboard Application Schematic

## 6 Package Information

Figure 4 shows the MMM6025 9.85 × 9.0 × 1.4 mm HDI package case outline. Figure 5 on page 15 shows the bottom view.

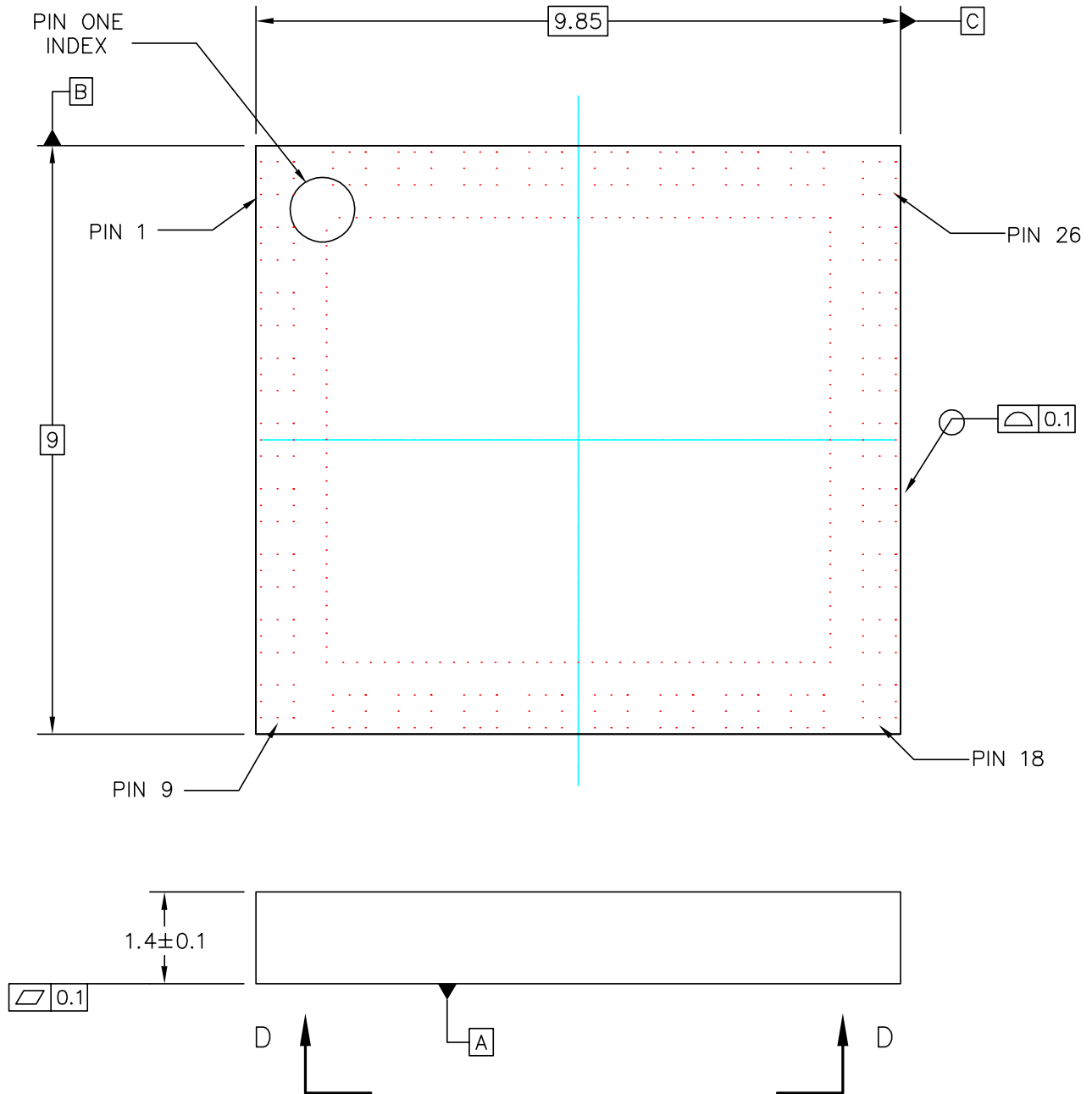
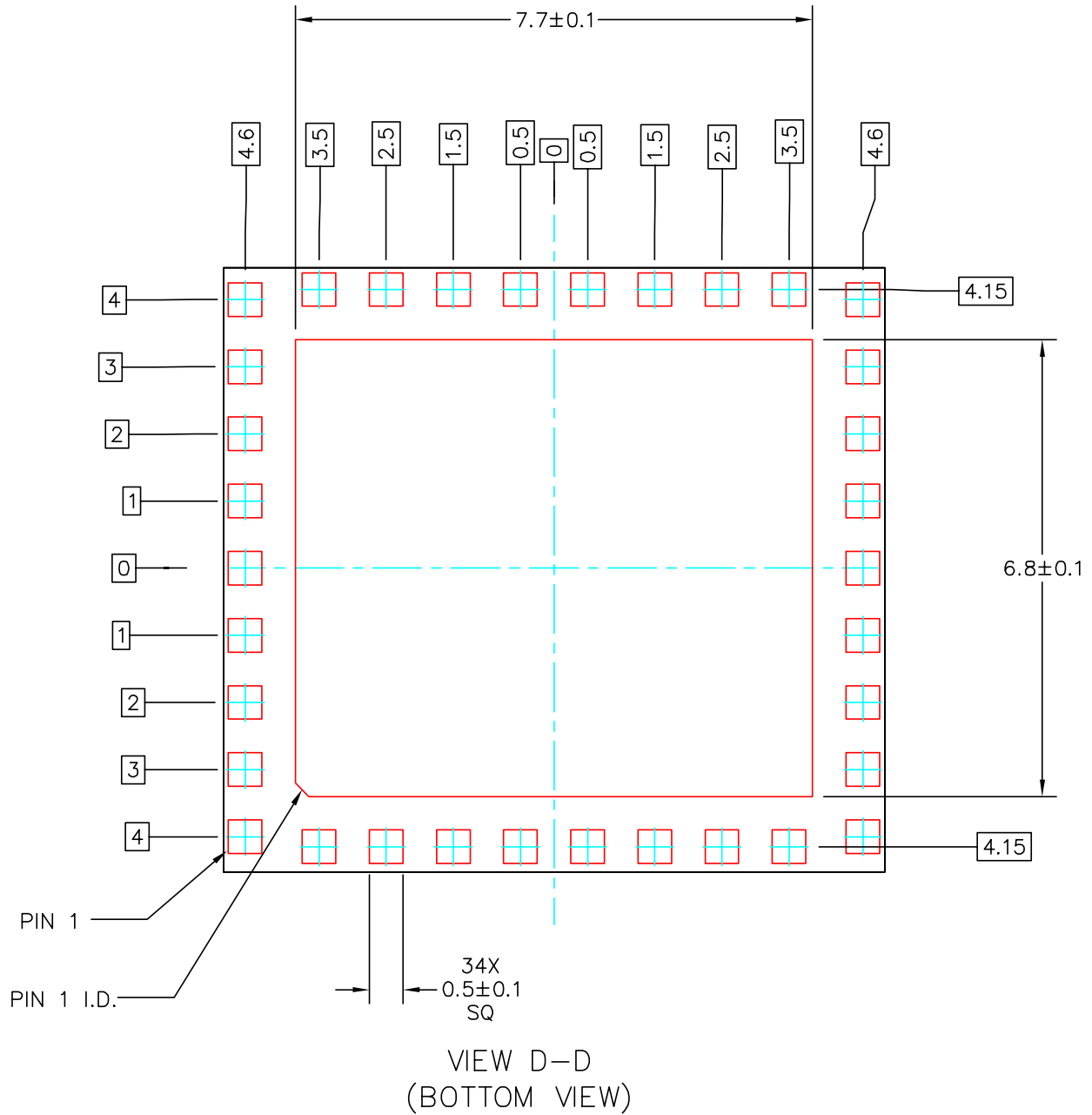


Figure 4. Package Outline



NOTES:

1. CONTROLLING DIMENSION: MILLIMETERS
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-994.
3.  $\varnothing 0.1 \text{ (C) A B C}$  APPLIES TO ALL PAD LOCATIONS.

**Figure 5. Package Outline—Bottom View**

# 7 Product Documentation

This data sheet is labeled as a particular type: Product Preview, Advance Information, or Technical Data. Definitions of these types are available at: <http://www.freescale.com> on the documentation page.

Table 11 summarizes revisions to this document since the previous release (Rev. 5).

**Table 11. Revision History**

Location	Revision
Multiple locations	Changed Case Temp to Ambient Temp. Added Tape and Reel and Lead Free information.

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[support.japan@freescale.com](mailto:support.japan@freescale.com)

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