

## Datasheet

### Main Features

- 10-bit Resolution
- 1.2 Gsps Guaranteed Conversion Rate, 1.4 Gsps Typical
- 4:1 Integrated Parallel MUX
- PECL/LVDS Differential Data and Clock Inputs
- 2 Vpp Differential Analog Output Swing
- Output Impedance: 50Ω Single-ended, 100Ω Differential
- Programmable DSP Clock
- Power Up Reset for Easy Synchronization of Several DACs
- Dual Power Supply: ±5V
- CBGA 255 Package for = C and V Grades
- CI-CGA 255 Package for M Grade
- Evaluation Board TSEV86101G2BGL

### Performance

- Broadband
  - NPR: 49 dB at  $F_s = 1.2$  Gsps: 9.5 bits equivalent (20 MHz to 580 MHz Broadband Pattern, 25 MHz Notch Centered Around 250 MHz)
- Single Tone
  - SFDR Baseband (Full First Nyquist Zone):
    - 70 dBFS at  $F_s = 1.0$  Gsps
    - 68 dBFS at  $F_s = 1.2$  Gsps
  - SFDR in Third Nyquist Zone
    - 69 dBFS at  $F_s = 1.2$  Gsps,  $F_{out} = 5 \times F_s/4$
    - > 60 dBFS at  $F_s = 1.2$  Gsps,  $F_{out} = 5 \times F_s/4 \pm 150$  MHz (–12 dBm Constant Output Power over 300 MHz Instantaneous Bandwidth)
- Multi-tone
  - Eight-tone IMD: 70 dBFS at  $F_s = 1.2$  Gsps and 500 MHz Baseband
  - Eight Tones Ranging from 80 MHz to 517.5 MHz, 62.5 MHz Spacing
- Total Power Dissipation = 3.6W

### Applications

- Direct Digital Synthesis (DDS) for Broadband Applications
- Digital Beam Forming
- Automatic Test Equipment (ATE)
- Instrumentation: Arbitrary Waveform Generator

### Screening

- Temperature Range:
  - C grade:  $0^\circ\text{C} < T_C; T_J < 90^\circ\text{C}$
  - V grade:  $-40^\circ\text{C} < T_C; T_J < 110^\circ\text{C}$
  - M grade:  $-55^\circ\text{C} < T_C; T_J < 125^\circ\text{C}$

Visit our website: [www.e2v.com](http://www.e2v.com)  
for the latest version of the datasheet

## 1. Description

The TS86101G2B is a 10-bit 1.2 Gsps DAC with an integrated 4:1 multiplexer, allowing easy interfacing with standard FPGAs. The enhanced linearity and Noise Power Ratio (NPR) performance (9.5 bits equivalent at 1.2 Gsps) over 550 MHz instantaneous bandwidth make this product particularly suitable for high-end applications such as arbitrary waveform generators and broadband DDS systems.

## 2. Specifications

**Table 2-1.** Absolute Maximum Ratings

Parameter	Symbol	Comments	Value	Unit
Positive digital power supply	$V_{CCD}$		GND to 6.0	V
Negative digital power supply	$V_{EED}$		-6.0 to GND	V
Negative analog power supply	$V_{EEA}$		-6.0 to GND	V
Maximum difference between negative supply voltages	$V_{EED} - V_{EEA}$		0.7	V
Digital inputs Port Y = A/B/C/D	<Y0_T; Y9_T> or <Y0_F; Y9_F>		$V_{IL} > -0.25$ $V_{IH} < 5.5$	V
Maximum difference digital inputs Port Y = A/B/C/D	<Y0_T; Y9_T> <Y0_F; Y9_F>		$V_{IH} - V_{IL} < 1.4$	Vp
Data ready clock input	D_CK_T, D_CK_F		$V_{IL} > -0.25$ $V_{IH} < 5.5$	V
Maximum difference between D_CK_T and D_CK_F	D_CK_T, D_CK_F		$V_{IH} - V_{IL} < 1.4$	Vp
Master clock input	CW_IN_T, CW_IN_F		$V_{IL} > -3.5$ $V_{IH} < 0.75$	V
Maximum difference between CW_IN_T and CW_IN_F	CW_IN_T, CW_IN_F		$V_{IH} - V_{IL} < 1.2$	Vp
Digital shift select voltage	CS		GND to $V_{CCD}$	V
Maximum junction temperature	$T_J$		135	°C
Storage temperature	$T_{stg}$		-65 to 150	°C
Lead temperature	$T_{balls}$		250 (during 10s max.)	°C

- Notes:
1. Maximum ratings are limiting values only (referenced to GND = 0V), and are to be applied individually, while other parameters are within specified operating conditions. Long exposure to maximum ratings may affect device reliability. The use of a thermal heat sink is mandatory (refer to [“Thermal and Moisture Characteristics” on page 36.](#))
  2. Maximum ratings enable active inputs with MUXDAC power off.
  3. Maximum ratings enable floating inputs with MUXDAC power on.

**Table 2-2.** Recommended Conditions of Use

Parameter	Symbol	Comments	Typ	Unit
Positive digital power supply	$V_{CCD}$		5	V
Negative digital power supply <sup>(1)</sup>	$V_{EED}$		-5	V
Negative analog power supply <sup>(1)</sup>	$V_{EEA}$		-5	V
Differential digital inputs Port Y = A, B, C, D $V_{IH}$ $V_{IL}$ Swing (on each single-ended input)	<Y0_T; Y9_T> <Y0_F; Y9_F>		1.4 1.0 0.2	V V Vp
Differential data ready clock inputs $V_{IH}$ $V_{IL}$ Swing (on each single-ended input)	D_CK_T D_CK_F		1.4 1.0 0.2	V V Vp
Differential master clock inputs Swing (on CW_IN_T)	CW_IN_T CW_IN_F	Single-ended mode: master clock applied on CW_IN_T through 10 nF AC capacitor. CW_IN_F grounded through 10 nF AC capacitor	0.316	Vp
Master clock input power level	PCW_IN_T PCW_IN_F	Single-ended mode	0	dBm
Operating temperature range	$T_C, T_J$	Commercial "C" grade Industrial "V" grade Military "M" grade	0°C < $T_C$ ; $T_J$ < 90°C -40°C < $T_C$ ; $T_J$ < 110°C -55°C < $T_C$ ; $T_J$ < 125°C	°C

Note: 1.  $V_{EEA}$  and  $V_{EED}$  are internally short circuited through the chip substrate (4Ω equivalent resistance between  $V_{EEA}$  and  $V_{EED}$ ). Therefore,  $V_{EEA}$  and  $V_{EED}$  must be externally driven by the same power supply source with  $V_{EEA}$  and  $V_{EED}$  board planes short circuited, and power supply connected to the  $V_{EEA}$  plane.

## 2.1 Electrical Operating Characteristics

**Table 2-3.** Electrical Operating Characteristics:  $V_{CCD} = 5V$ ,  $V_{EEA}$  and  $V_{EED} = -5V$ , LVDS Input Level,  $T_J = 85^\circ C$

Parameter	Symbol	Test Level	Min	Typ	Max	Unit
Resolution		4		10		bits
ESD protection		4	1600			V
<b>Power Requirements</b>						
Positive supply voltage (digital)	$V_{CCD}$	1	4.75	5	5.25	V
Positive supply current	$I_{VCCD}$	1		33	40	mA
Negative supply voltage						
Analog	$V_{EEA}$	1	-5.25	-5	-4.75	V
Digital	$V_{EED}$		-5.25	-5	-4.75	V
Negative supply current						
Analog	$I_{VEEA}$	1		380	430	mA
Digital	$I_{VEED}$			300	340	mA
Power dissipation	$P_D$	1		3.6	4.0	W
<b>Digital Inputs and Data Ready Clock Input</b>						
Logic compatibility			2.5V PECL/3.3V PECL/LVDS			
Digital input voltages (differential):						
- Logic 0 voltage	$V_{IL}$		-0.2	1.0	2.7	V
- Logic 1 voltage	$V_{IH}$	4	0.3	1.4	2.9	V
- Swing (on each single-ended input)	$V_p$		0.1	0.2	0.7	Vp
- Common mode	CM		0.2	1.2	2.8	V
Input capacitance (die) from each single-ended input to ground		4		2		pF
Input resistance:						
- Single-ended		1		50		$\Omega$
- Differential				100		$\Omega$
<b>Master Clock Input (CW_IN_T, CW_IN_F)</b>						
Logic compatibility			ECL/PECL/LVDS (providing AC coupling capacitors)			
AC coupled digital input voltages (differential):						
Single-ended operation:						
- Swing (on single-ended input used)	$V_p$	4	0.2	0.3	0.8	Vp
Differential operation:						
- Swing (on each single-ended input)	$V_p$		0.1	0.15	0.4	Vp
Power level:						
- Single-ended operation		4	-4		8	dBm
- Differential operation (power on each single-ended input)			-10		2	dBm
Input capacitance (die)		4		2		pF
Input resistance:						
- Single-ended		4		50		$\Omega$
- Differential				100		$\Omega$

**Table 2-3.** Electrical Operating Characteristics:  $V_{CCD} = 5V$ ,  $V_{EEA}$  and  $V_{EED} = -5V$ , LVDS Input Level,  $T_J = 85^\circ C$   
(Continued)

Parameter	Symbol	Test Level	Min	Typ	Max	Unit
<b>DSP Clock Output (DSP_CK_T, DSP_CK_F)</b>						
Logic compatibility		4	PECL/LVDS (providing AC coupling capacitors and pull-down resistors to change the common mode voltage)			
Digital output voltages (true or false signals): - Logic 0 voltage - Logic 1 voltage (only depends on $V_{CCD}$ ) - Swing (on each single-ended output) - Common mode voltage	$V_{OL}$ $V_{OH}$ $V_{pp}$ CM	1	$V_{CCD} - 0.38$ $V_{CCD} - 0.22$ 0.15	$V_{CCD} - 0.35$ $V_{CCD} - 0.16$ 0.19 4.75	$V_{CCD} - 0.30$ $V_{CCD} - 0.13$ 0.22	V V V <sub>pp</sub> V
<b>Analog Outputs</b>						
Differential full-scale output voltage (100Ω differentially terminated) Full-scale output power (differential output) Full-scale power at $1/\sqrt{2}$ balun output 50Ω terminated)	(OUT_T, OUT_F) $P_{OUTD}$ $P_{OUTB}$	4		2 7 7		V <sub>pp</sub> dBm dBm
Single-ended full-scale output voltage (50Ω terminated) Full-scale output power (single-ended output)	OUT_T or OUT_F $P_{OUTS}$	4		1 4		V <sub>pp</sub> dBm
Single ended mid-scale output voltage (50Ω terminated)		5		-600		mV
Output capacitance (from each single-ended output to ground)	$C_{OUT}$	4		1		pF
Output VSWR (50Ω // 2 pF load on each single-ended output): - From DC to 600 MHz - From 600 MHz to 1.5 GHz	VSWR	4			1.25:1 2.75:1	
Deviation from theoretical $\text{Sinx}/x$ (50Ω // 2 pF load on each single ended output at $F_s = 1.2$ Gsps) $F_{out}$ up to 600 MHz		4		-1.5	-2.0	dB
<b>AC Performance</b>						
Single tone Spurious free dynamic range <sup>(1)</sup> : $F_s = 600$ Msps; $F_{out} = 12.5$ MHz (-6 dBFS)		4	61 67	65 71		dBc dBFS
$F_s = 600$ Msps; $F_{out} = 287.5$ MHz (-6 dBFS)	SFDR	1	57 67	62 72		dBc dBFS
$F_s = 1.2$ Gsps; $F_{out} = 25$ MHz (-6 dBFS)		4	58 64	62 68		dBc dBFS
$F_s = 1.2$ Gsps; $F_{out} = 575$ MHz (-6 dBFS)		4	53 63	58 68		dBc dBFS

**Table 2-3.** Electrical Operating Characteristics:  $V_{CCD} = 5V$ ,  $V_{EEA}$  and  $V_{EED} = -5V$ , LVDS Input Level,  $T_J = 85^\circ C$   
(Continued)

Parameter	Symbol	Test Level	Min	Typ	Max	Unit
Single tone Spurious free dynamic range in third Nyquist zone <sup>(2)</sup> : assuming an $F_s/4$ bandwidth centered around $5 F_s/4$ , with a sin x/x pre-compensation for a constant output power of $-12.3$ dBm over the band of interest): see <a href="#">Figure 3-6 on page 12</a> .  $F_s = 1.2$ Gsps; $F_{out} = F_s + 150$ MHz = 1350 MHz  $F_s = 1.2$ Gsps; $F_{out} = F_s + 450$ MHz = 1650 MHz	IF SFDR	4	36 65  39 59	40 69  43 63		dBc dBFS  dBc dBFS
SFDR sensitivity over temperature and power supplies range		4			$\pm 3$	dB
Signal independent spur (clock-related spur) $F_s = 1.2$ Gsps: $F_s/4$ power level (first Nyquist zone) $F_s/2$ Power level (first Nyquist zone)		4		-80 -72		dBm dBm
Signal-to-noise ratio (DC to Nyquist) $F_s = 1.2$ Gsps; $F_{out} = 375$ MHz ( $-15$ dBFS)	SNR	4	58	60		dBFS
Multi-tone inter-modulation: $F_s = 1.2$ Gsps Four tones at 100 MHz spacing (150 to 450 MHz) ( $-12$ dBFS) Eight tones at 62.5 MHz spacing (80 to 517.5 MHz) ( $-18$ dBFS)	IMD	4	63 65	68 70		dBFS dBFS
Broadband noise power ratio: At $-12$ dBFS peak to rms optimum loading factor $F_s = 1.2$ Gsps, 20 to 580 MHz broadband pattern, 25 MHz Notch centered around 250 MHz	NPR	4	47	49		dB
<b>DC Accuracy</b>						
Differential non-linearity	DNL+	4		0.25		LSB
Differential non-linearity	DNL-	4		-0.25		LSB
Integral non-linearity	INL+	4		0.25		LSB
Integral non-linearity	INL-	4		-0.25		LSB
DC gain - Initial gain error <sup>(3)</sup> - DC gain dispersion <sup>(4)</sup> - DC gain sensitivity to power supplies - DC gain drift over temperature		1 1 1 4			$\pm 3.5\%$ $\pm 2.3\%$ $\pm 1.5\%$ -400	%FS %FS %FS ppm/ $^\circ C$
Mid-scale output voltage <sup>(5)</sup>		5		-600		mV

**Table 2-3.** Electrical Operating Characteristics:  $V_{CCD} = 5V$ ,  $V_{EEA}$  and  $V_{EED} = -5V$ , LVDS Input Level,  $T_J = 85^\circ C$   
(Continued)

Parameter	Symbol	Test Level	Min	Typ	Max	Unit
<b>Switching Performance</b>						
Maximum operating clock frequency		4	1.2	1.4		Gsps
Minimum operating clock frequency <sup>(6)</sup>		4			10	Msp

- Notes:
1. SFDR is the ratio of the magnitude of the first (main) harmonic and the highest other harmonic measured over the frequency band DC to  $F_s/2$  (first Nyquist zone).
  2. SFDR is the ratio of the magnitude of the first (main) harmonic and the highest other harmonic measured over the frequency band  $F_s$  to  $3 \times F_s/2$  (third Nyquist zone).
  3. Initial gain error corresponds to the deviation of the DC gain center value from the unity gain.
  4. DC gain dispersion excludes initial gain error.
  5. Mid-scale output voltage is measured with a  $100\Omega$  differential load on DAC output.
  6. Minimum operating clock frequency can be DC. Actually linked to clock input AC coupling external capacitor.

## 2.2 Timing Characteristics

**Table 2-4.** Timing Characteristics: 50Ω // 2pF Loading Conditions on Each Single-ended Output. Absolute Timing Values are Given at Package Input/Output Balls

Parameter	Test Level	Min	Typ	Max
Data and data ready maximum allowable input jitter	4			300 ps peak-to-peak
Input data rise/fall time <sup>(1)</sup> Data ready rise/fall time <sup>(1)</sup>	4			500 ps 500 ps
Tsetup <sup>(2)</sup> see <a href="#">Figure 5-2 on page 21</a>	4	-1.3 ns		
Thold <sup>(2)</sup> see <a href="#">Figure 5-2 on page 21</a>	4	2.5 ns		
Input data rate (ports A, B, C and D)	4			350 MWords/s
Input data pulse width (ports A, B, C and D)	4	5.7 ns (at 350 MWord/s)		
CW_IN clock input frequency	4			1400 MHz
CW_IN master clock input jitter <sup>(3)</sup>	4			1 ps rms
CW_IN to DSP clock output delay with clock shift 0000	4		2.1 ns + 1 clock cycle	
CW_IN to DSP clock output delay with clock shift 1111	4		5.2 ns + 1 clock cycle	
DSP clock output phase tuning range	1		0 to 3.1 ns	
DSP clock output phase tuning steps	1		200 ps	
Data ready to CW_IN clock timing: ( <a href="#">Figure 5-4 on page 22</a> ) Forbidden area	4			600 ps
Pipeline delay <sup>(4)</sup> TOD <sup>(5)</sup> TPD <sup>(5)(6)</sup> (propagation delay) Analog output rise/fall time <sup>(7)</sup>	4		1 clock cycle 3.7 ns Pipeline delay + TOD 180 ps	

- Notes:
1. Digital input data rise/fall time: defined between 20% to 80%.
  2. Exclusive of period (pp) jitter on both Data and on Data Ready.
  3. CW\_IN clock input jitter over 5 GHz bandwidth. MUXDAC also operates with CW\_IN clock showing more jitter but this may degrade performance (SNR and NPR).
  4. Guaranteed by design.
  5. See ["Definitions of Terms" on page 35](#).
  6. TPD can be directly measured at package input/output, between CW\_IN clock and analog output.
  7. Full-scale analog output (10% to 90%).



### 2.3 Explanation of Test Levels

**Table 2-5.** Explanation of Test Levels

Num	Characteristics
1	100% production tested at +25°C <sup>(1)</sup>
2	100% production tested at +25°C, and sample tested at specified temperatures <sup>(1)</sup>
3	Sample tested only at specified temperatures
4	Parameter is guaranteed by design and characterization testing (thermal steady-state conditions at specified temperature)
5	Parameter is a typical value only

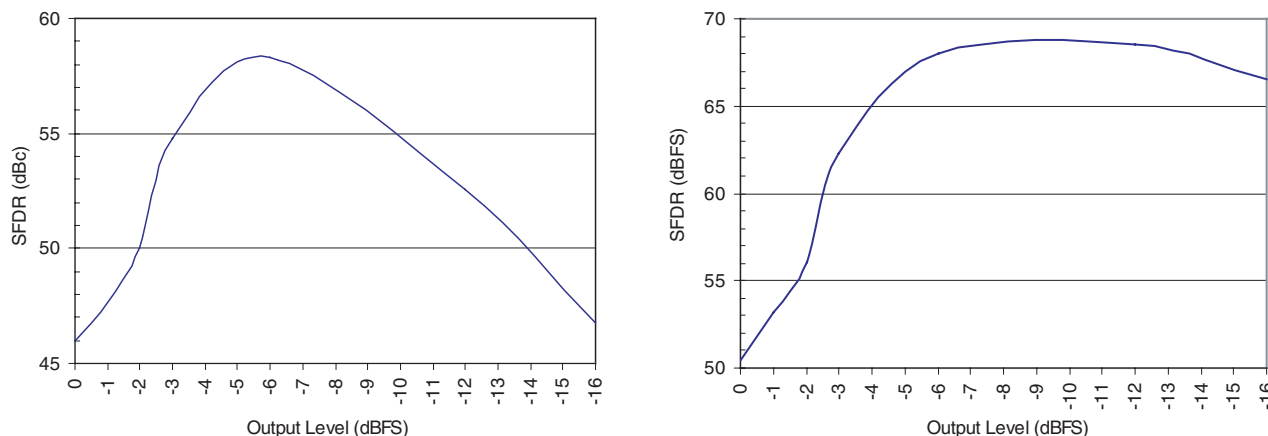
Notes: 1. The level 1 and 2 tests are performed at 100 Msps (600 Msps for SFDR performance).  
 2. Only MIN and MAX values are guaranteed (typical values are issued from characterization results).

### 3. Typical Characteristics

The device’s typical characteristics are the following, unless stated otherwise:

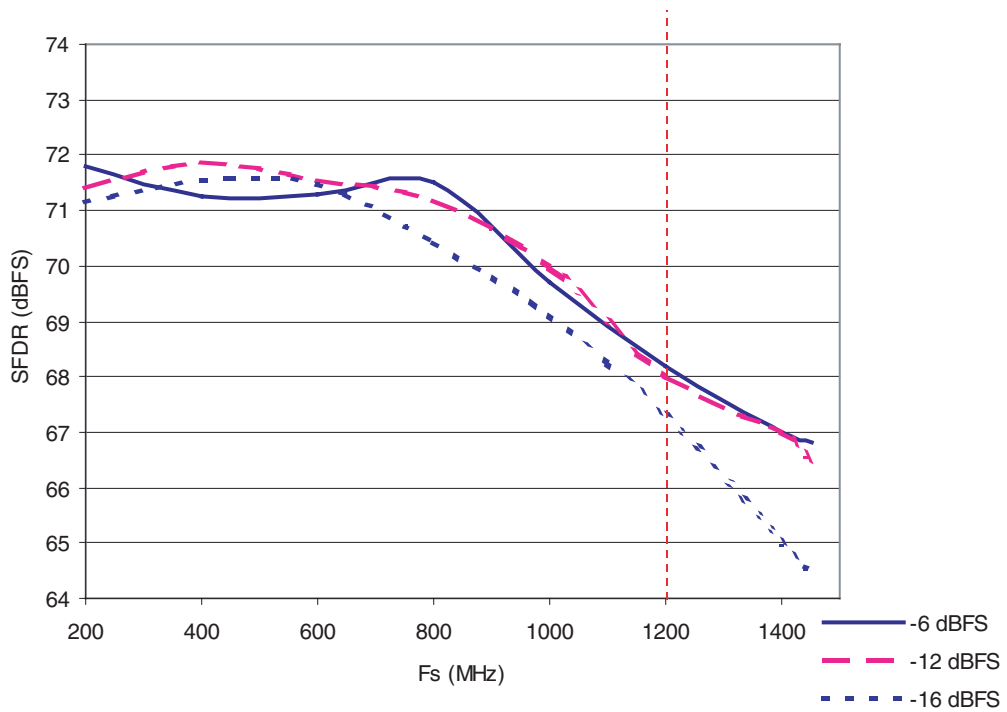
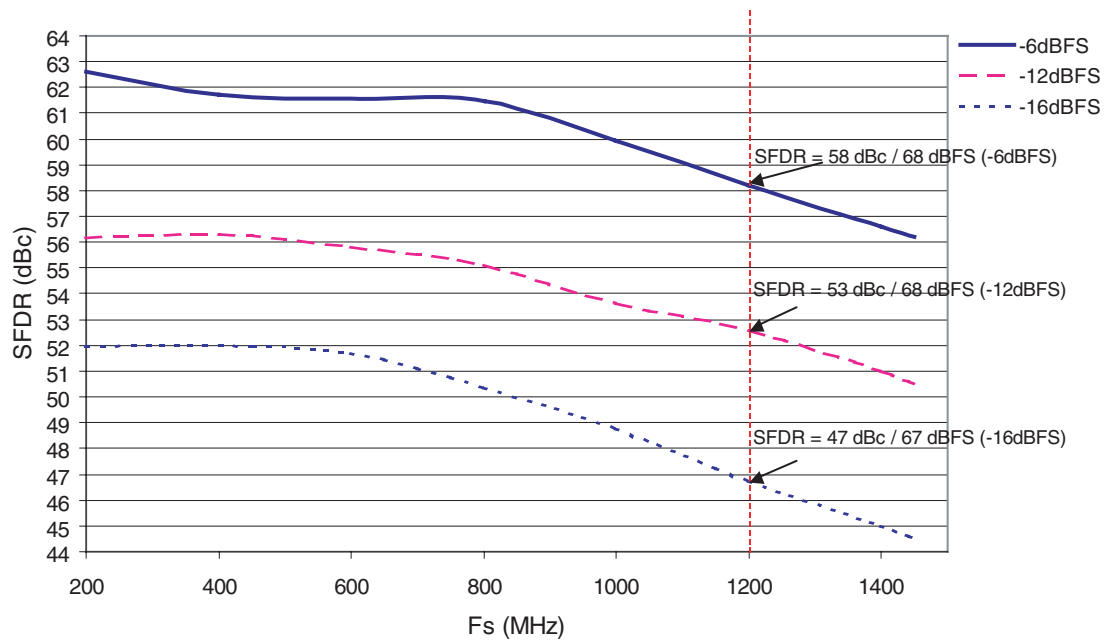
- $T_J = 85^\circ\text{C}$ ,  $V_{CCD} = 5\text{V}$ ,  $V_{EEA} = -5\text{V}$ ,  $V_{EED} = -5\text{V}$
- 100Ω differential output, 0 dBFS = 7 dBm
- Full-scale analog output voltage = 2 Vpp if (50Ω // 2pF) × 2 differentially-terminated
- SFDR up to Nyquist<sup>(1)</sup>

**Figure 3-1.** SFDR at  $F_s = 1.2\text{ Gps}$  Against Output Level in Nyquist Conditions ( $F_{out} = 575\text{ MHz}$ )



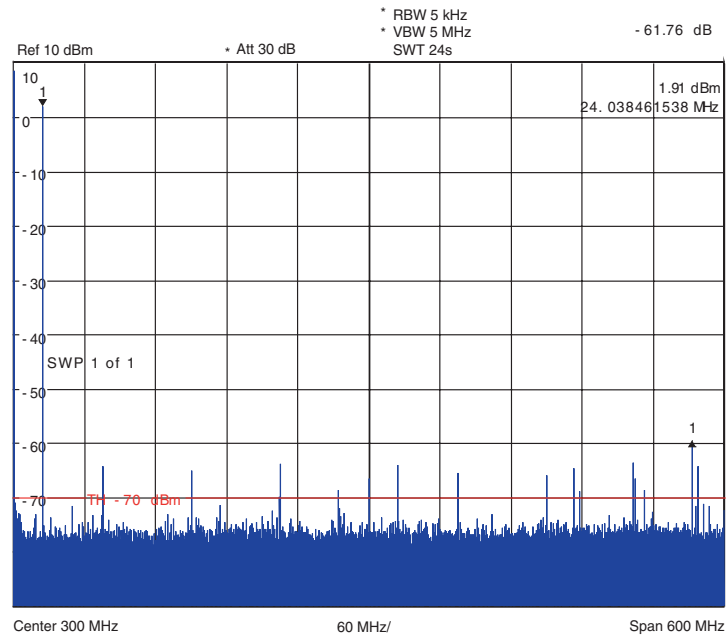
- Notes:
1. SFDR performance (expressed in dBc) is optimum near -6 dBFS.
  2. SFDR performance (expressed in dBFS) is quasi-constant for output levels below -6 dBFS. This means that the level of spurs remains quasi-unchanged when lowering the amplitude of the fundamental.
  3. SFDR is the ratio of the magnitude of the first (main) harmonic and the highest other harmonic measured over the frequency band DC to  $F_s/2$ .
  4. In single-ended operation, 0 dBFS = full-scale = 1 Vpp = 0.5V peak over 50Ω = -6 dBV = 4 dBm. In differential mode, 0 dBFS = full-scale = 2 Vpp = 0.707 V peak over 100Ω = -3 dBV = 7 dBm.
  5. The power level at the DAC’s output is given by both the digital sinusoidal input level (dBFS) and the theoretical sin X/X deviation, which is  $F_{out}$ -dependent. For example, considering the SFDR with a -10 dBFS digital sinusoidal input and  $F_{out} = 499\text{ MHz}$ ,  $F_s = 1\text{ Gps}$ , the differential output power level of the single tone at  $F_{out} = 499\text{ MHz}$  is -6.9 dBm (-10 dBFS = -3 dBm and the theoretical deviation of sin X/X is -3.9 dB in Nyquist).

**Figure 3-2.** SFDR Against Sampling Rate ( $F_{out}/F_s = 0.479$ ) for Three Output Levels (-6 dBFS, -12 dBFS and -16 dBFS)

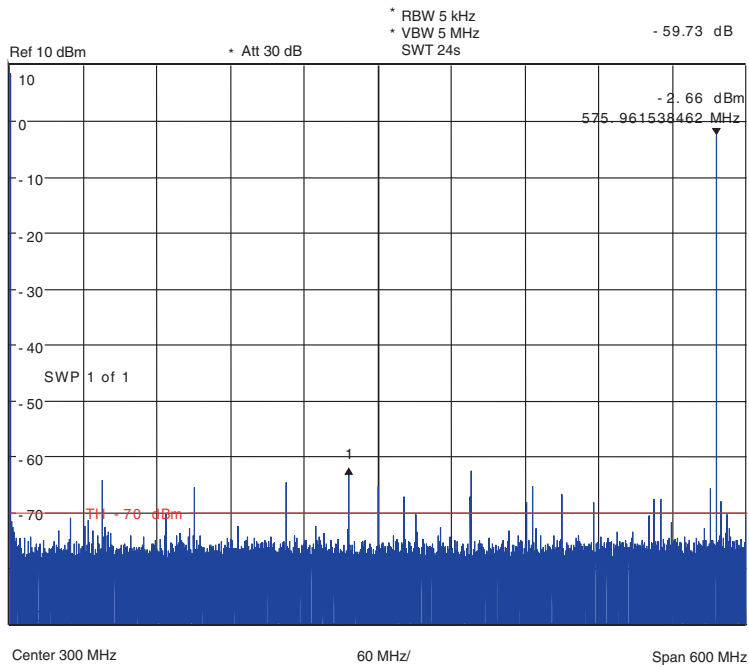


Note: SFDR performances (expressed in dBFS) are quasi-equivalent for output levels below -6 dBFS.

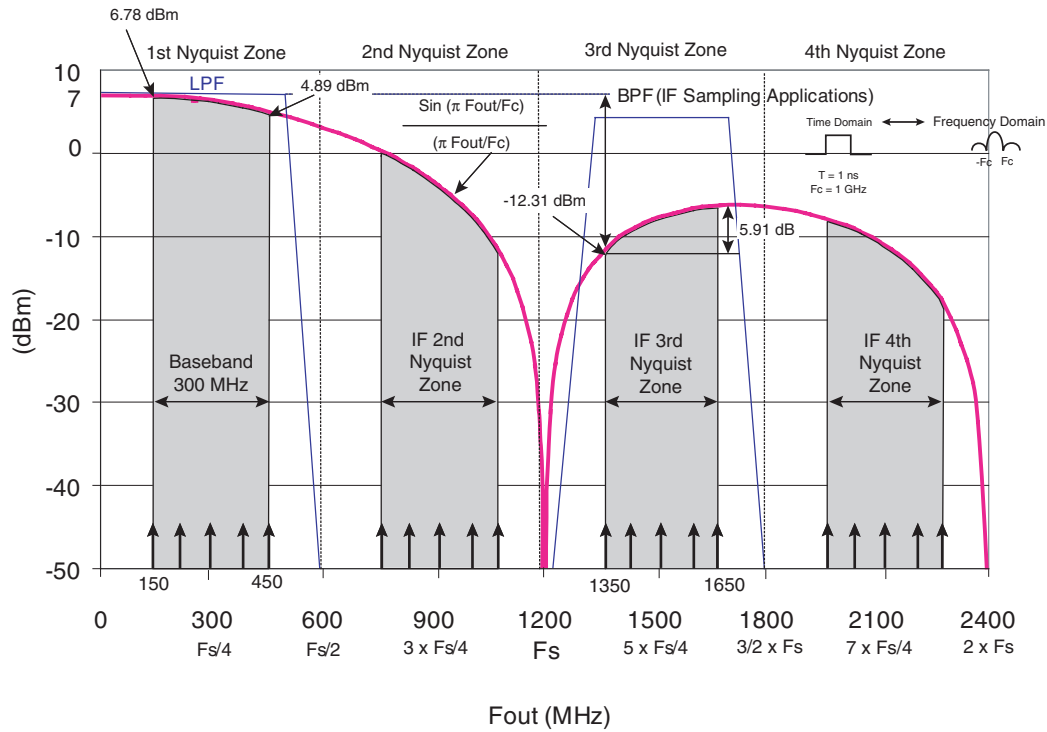
**Figure 3-3.** Single-tone Spectrum in First Nyquist  
 $F_s = 1.2$  Gps in First Nyquist Zone ( $F_{out} = 25$  MHz,  $-6$  dBFS) SFDR = 62 dBc (68 dBFS)



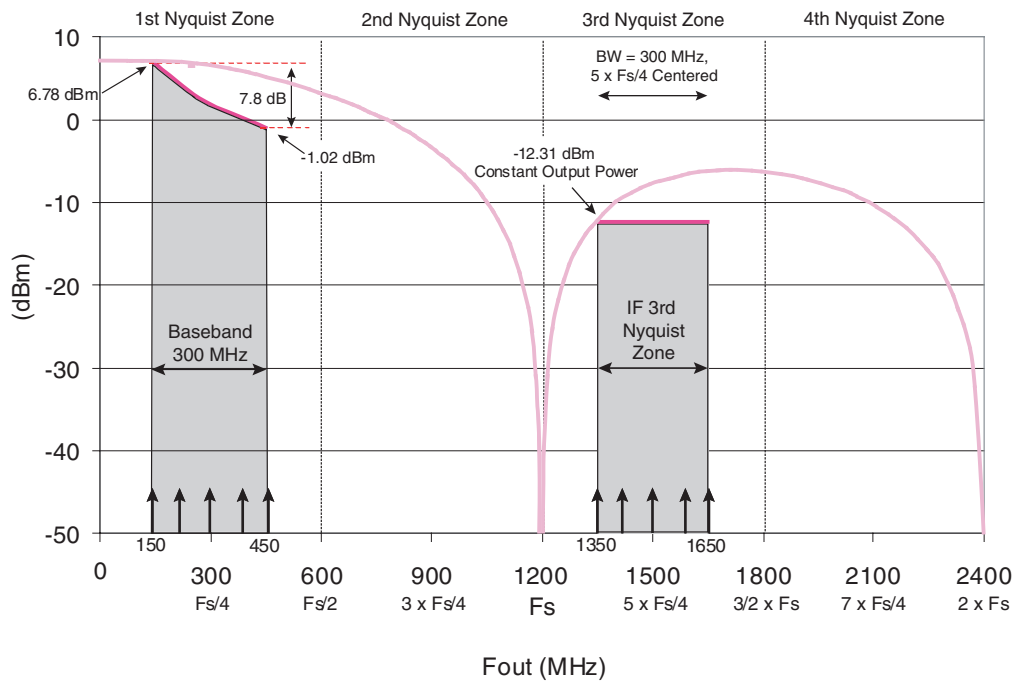
**Figure 3-4.** Single-tone Spectrum in First Nyquist  
 $F_s = 1.2$  Gps in First Nyquist Zone ( $F_{out} = 575$  MHz,  $-6$  dBFS) SFDR = 59 dBc (69 dBFS)



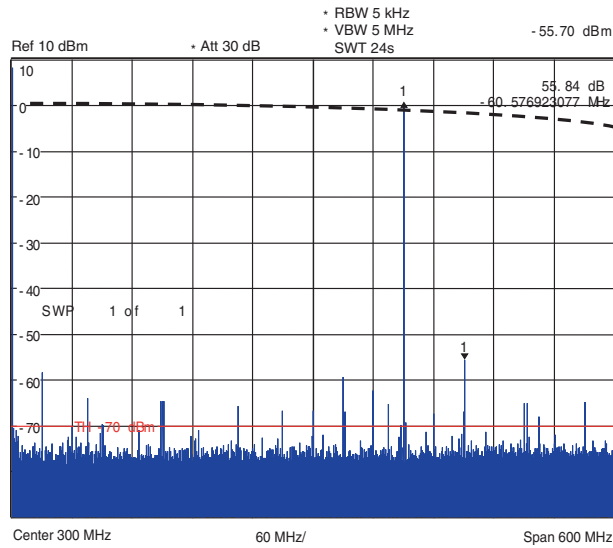
**Figure 3-5.** Signal Dependent Spur SFDR Performance. Sinc Function (from Zero Order Hold Function) DAC Full-scale Differential Output Without Pre-compensation ( $F_s = 1.2$  Gsps)



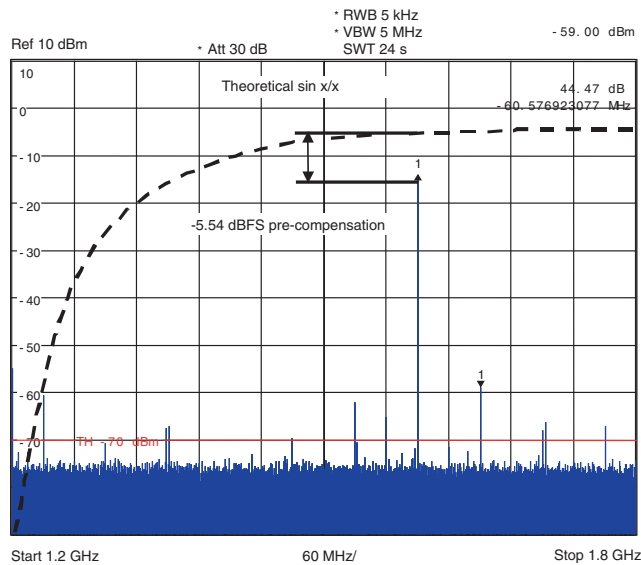
**Figure 3-6.** Signal Dependent Spur SFDR Performance at 1.2 Gsps, 300 MHz Pattern Width Centered on  $5 F_s/4$ . DAC Full-scale Output with Sinc Pre-compensation for Constant Output Power in Third Nyquist Zone



**Figure 3-7.** Single-tone Spectrum in First Nyquist  $F_s = 1.2$  Gps in First Nyquist Zone ( $F_{out} = 390$  MHz,  $-5.5$  dBFS) SFDR = 56 dBc (63 dBFS)

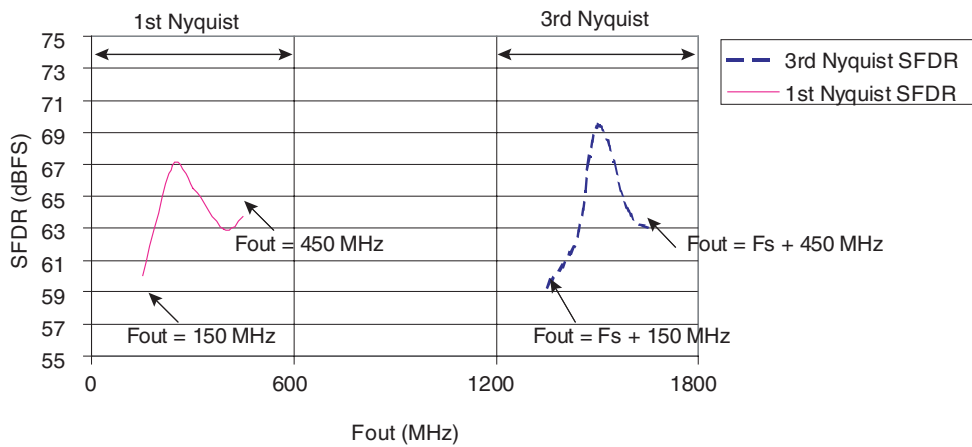


**Figure 3-8.** Single-tone Spectrum in Third Nyquist  $F_s = 1.2$  Gps in Third Nyquist Zone ( $F_{out} = F_s + 390$  MHz = 1590 MHz) with Sinc Pre-compensation for Constant Output Power ( $-12.31$  dBm) in Third Nyquist Zone. SFDR = 44 dBc (64 dBFS)

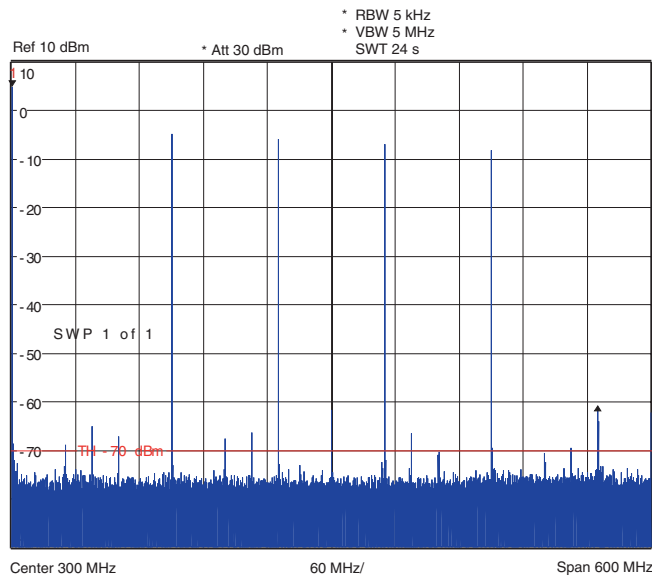


The absolute level of harmonics is equivalent in both the first and third Nyquist zones. The SFDR figures (in dBFS) are therefore similar in these two Nyquist zones. This shows that the MUXDAC can be used equivalently in the first and third Nyquist zones with equivalent performances (see [Figure 3-9 on page 14](#)).

**Figure 3-9.** Single-tone SFDR Performance in First and Third Nyquist Zones  
 $F_s = 1.2$  Gsps  
 $F_{out}$  Ranging from 150 MHz to 450 MHz, with Sinc Pre-compensation for Constant Output Power (-12.31 dBm) in Third Nyquist Zone



**Figure 3-10.** Four-tone Spectrum in First Nyquist Zone  
 $F_s = 1.2$  Gsps  
 100 MHz spacing (-12 dBFS):  $F_{out1} = 150$  MHz,  $F_{out2} = 250$  MHz,  $F_{out3} = 350$  MHz,  $F_{out4} = 450$  MHz  
 Four-tone IMD = 68 dBFS

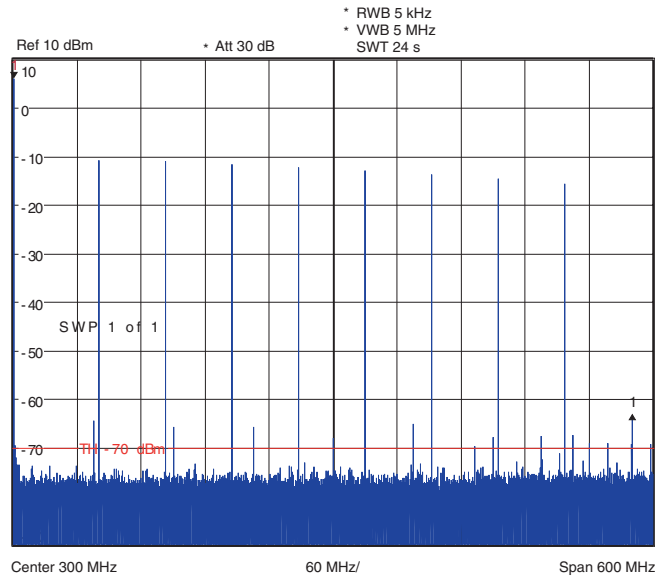


**Figure 3-11.** Eight-tone Spectrum in First Nyquist Zone

Fs = 1.2 Gsps

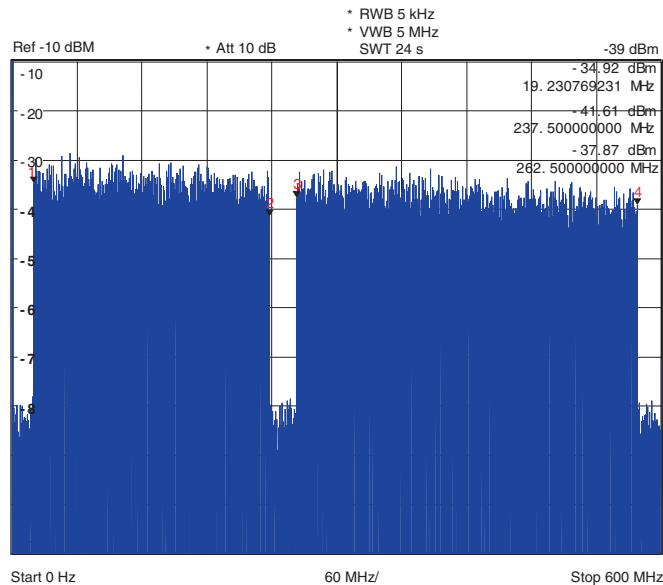
62.5 MHz Spacing (-18 dBFS): Fout1 = 80 MHz, Fout2 = 142.5 MHz, Fout3 = 205 MHz, Fout4 = 267.5 MHz, Fout5 = 330 MHz, Fout6 = 392.5 MHz, Fout7 = 455 MHz, Fout8 = 517.5 MHz

Eight-tone IMD = 70 dBFS



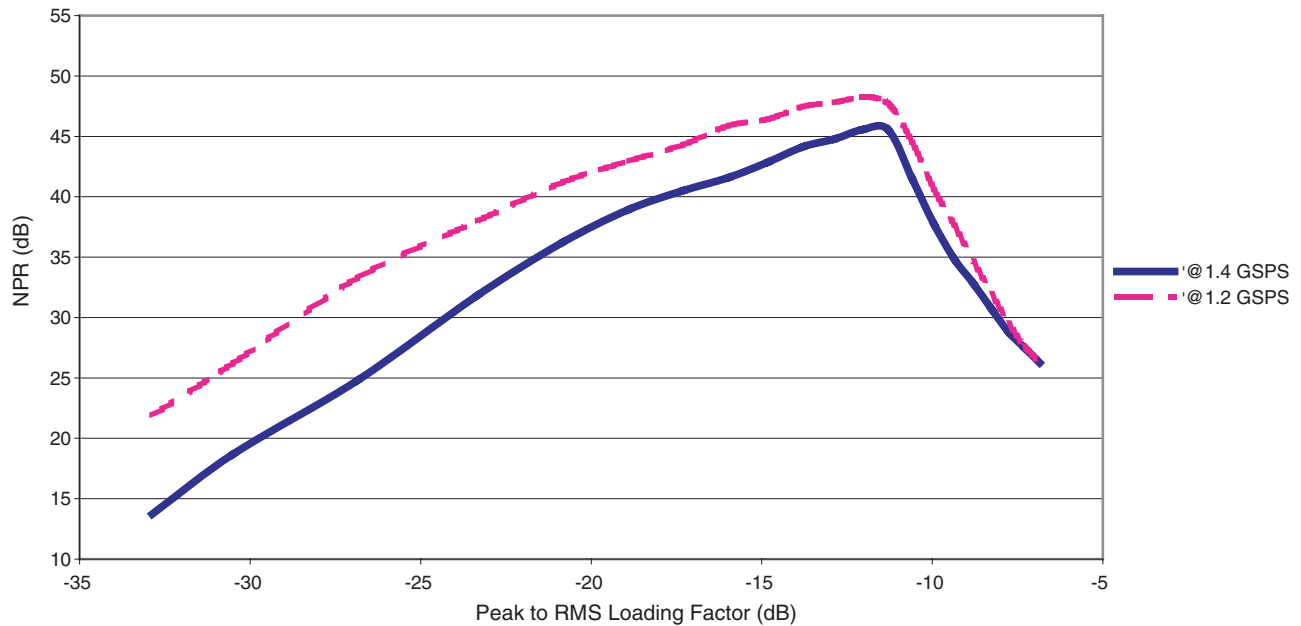
**Figure 3-12.** Noise Power Ratio (NPR)

Fs = 1.2 Gsps, 20 to 580 MHz Broadband Pattern, 25 MHz Notch Centered Around 250 MHz at -12 dBFS Loading Factor, NPR = 49 dB



The TS86101G2B DAC can directly synthesize a 550 MHz broadband analog output signal, featuring an equivalent ENOB of 9.5 bits at 1.2 Gsps, for an optimum peak to RMS loading factor of  $-12$  dBFS.

**Figure 3-13.** Noise Power Ratio (NPR) Against Peak to RMS Loading Factor  
 Fs = 1.2 Gsps, 20 to 580 MHz Broadband Pattern, 25 MHz Notch Centered Around 250 MHz  
 Fs = 1.4 Gsps, 20 to 680 MHz Broadband Pattern, 25 MHz Notch Centered Around 250 MHz





### 4. Pin Description

Figure 4-1. TS86101G2B Pin Configuration (Top View)

No ball/column on A1  
Index Corner

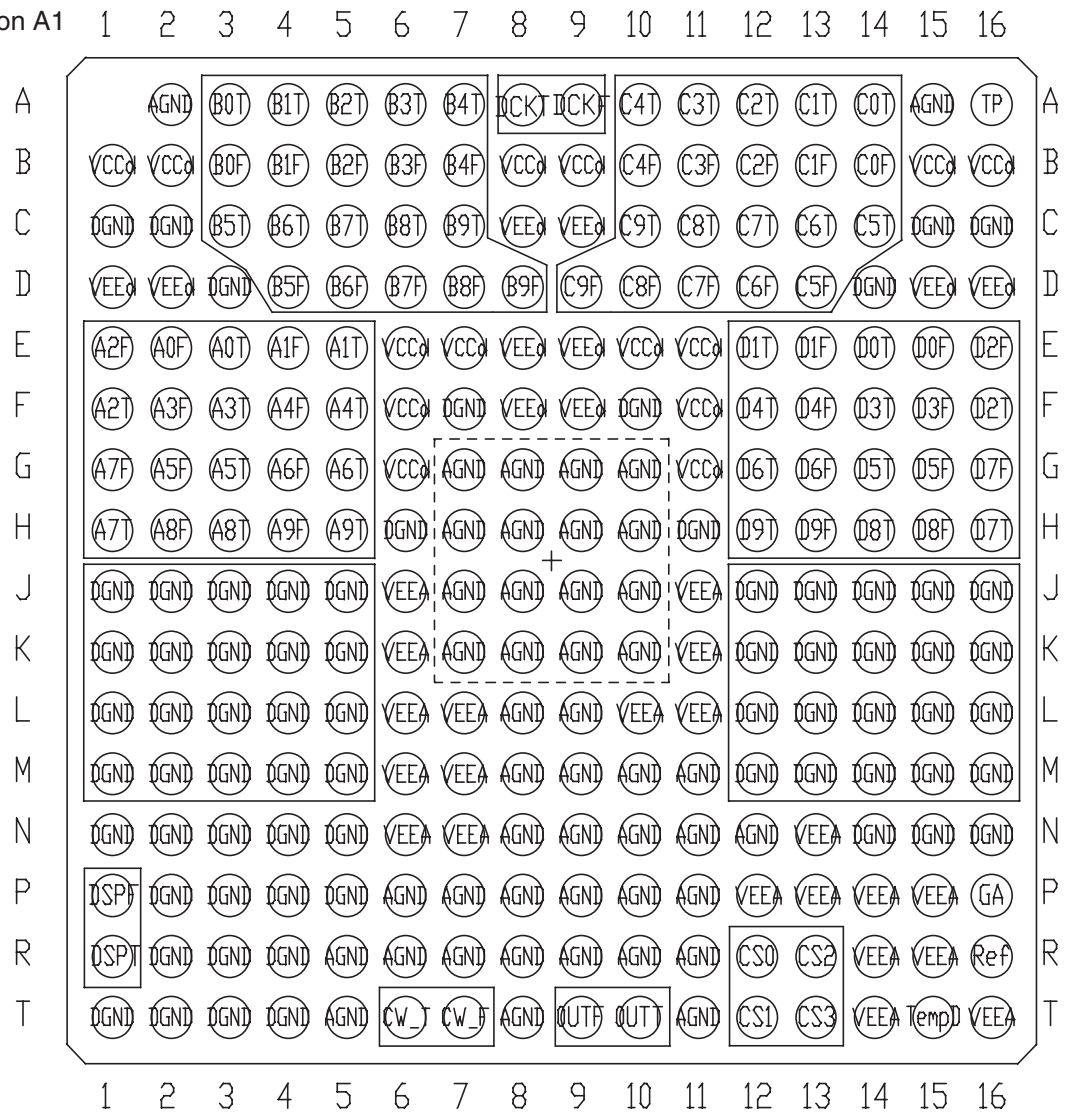


Table 4-1. TS86101G2B Pin Description

Symbol	Pin number	Function
<b>Power Supplies</b>		
DGND	C1, C2, C15, C16, D3, D14, F7, F10, H6, H11, J1, J2, J3, J4, J5, J12, J13, J14, J15, J16, K1, K2, K3, K4, K5, K12, K13, K14, K15, K16, L1, L2, L3, L4, L5, L12, L13, L14, L15, L16, M1, M2, M3, M4, M5, M12, M13, M14, M15, M16, N1, N2, N3, N4, N5, N14, N15, N16, P2, P3, P4, P5, R2, R3, R4, T1, T2, T3, T4	Ground pins
AGND	A2, A15, G7, G8, G9, G10, H7, H8, H9, H10, J7, J8, J9, J10, K7, K8, K9, K10, L8, L9, M8, M9, M10, M11, N8, N9, N10, N11, N12, P6, P7, P8, P9, P10, P11, R5, R6, R7, R8, R9, R10, R11, T5, T8, T11	Ground pins
V <sub>EEA</sub>	J6, J11, K6, K11, L6, L7, L10, L11, M6, M7, N6, N7, N13, P12, P13, P14, P15, R14, R15, T14, T16	Analog negative supply
V <sub>EED</sub>	C8, C9, D1, D2, D15, D16, E8, E9, F8, F9	Digital negative supply
V <sub>CCD</sub>	B1, B2, B8, B9, B15, B16, E6, E7, E10, E11, F6, F11, G6, G11	Digital positive power supply
<b>Digital Inputs</b>		
A0_T, A1_T, A2_T, A3_T, A4_T, A5_T, A6_T, A7_T, A8_T, A9_T	E3, E5, F1, F3, F5, G3, G5, H1, H3, H5	In-phase (+) digital input Port A A0_T is the LSB A9_T is the MSB
A0_F, A1_F, A2_F, A3_F, A4_F, A5_F, A6_F, A7_F, A8_F, A9_F	E2, E4, E1, F2, F4, G2, G4, G1, H2, H4	Inverted phase (-) Digital inputs B0_F is the inverted LSB B9_F is the inverted MSB
B0_T, B1_T, B2_T, B3_T, B4_T, B5_T, B6_T, B7_T, B8_T, B9_T	A3, A4, A5, A6, A7, C3, C4, C5, C6, C7	In-phase (+) digital input Port B B0_T is the LSB B9_T is the MSB
B0_F, B1_F, B2_F, B3_F, B4_F, B5_F, B6_F, B7_F, B8_F, B9_F	B3, B4, B5, B6, B7, D4, D5, D6, D7, D8	Inverted phase (-) digital inputs B0_F is the inverted LSB B9_F is the inverted MSB
C0_T, C1_T, C2_T, C3_T, C4_T, C5_T, C6_T, C7_T, C8_T, C9_T	A14, A13, A12, A11, A10, C14, C13, C12, C11, C10	In-phase (+) digital input Port C C0_T is the LSB C9_T is the MSB
C0_F, C1_F, C2_F, C3_F, C4_F, C5_F, C6_F, C7_F, C8_F, C9_F	B14, B13, B12, B11, B10, D13, D12, D11, D10, D9	Inverted phase (-) digital inputs C0_F is the inverted LSB C9_F is the inverted MSB
D0_T, D1_T, D2_T, D3_T, D4_T, D5_T, D6_T, D7_T, D8_T, D9_T	E14, E12, F16, F14, F12, G14, G12, H16, H14, H12	In-phase (+) digital input Port D D0_T is the LSB D9_T is the MSB
D0_F, D1_F, D2_F, D3_F, D4_F, D5_F, D6_F, D7_F, D8_F, D9_F	E15, E13, E16, F15, F13, G15, G13, G16, H15, H13	Inverted phase (-) digital inputs D0_F is the inverted LSB D9_F is the inverted MSB

**Table 4-1.** TS86101G2B Pin Description (Continued)

Symbol	Pin number	Function
<b>Analog Outputs</b>		
OUT_T	T10	In-phase (+) analog output signal
OUT_F	T9	Inverted phase (-) of analog output signal (Vout)
<b>Clock Inputs</b>		
D_CK_T	A8	In phase (+) PECL/LVDS Data Ready clock input signal. The digital data is loaded on the rising edge of the Data Ready clock signal
D_CK_F	A9	Inverted phase (-) of PECL/LVDS Data Ready clock input signal
CW_IN_T	T6	In-phase (+) of ECL/PECL/LVDS master clock input signal. The analog output is sampled and held on the rising edge of the CW_IN_T signal
CW_IN_F	T7	Inverted phase (-) of ECL/PECL/LVDS master clock input signal
<b>DSP Clock Outputs</b>		
DSP_CK_T	R1	In-phase (+) PECL/LVDS DSP clock output signal. The digital DSP clock
DSP_CK_F	P1	Inverted phase (-) of PECL/LVDS DSP clock output signal
<b>Additional Functions</b>		
CS_0, CS_1, CS_2, CS_3	R12, T12, R13, T13	Selectable shift for DSP output clock (adjust TDSP) 0 = TTL low or GND 1 = TTL high or left open
DIODE	T15	Die junction temperature monitoring
GA	P16	Gain adjust (to be connected to the REF pin)
Ref	R16	Reference for gain
TP	A16	Non-connected pin

## 5. Functional Description

### 5.1 Device Overview

The TS86101G2B is a 10-bit 1.2 Gbps DAC with an integrated 4:1 input MUX, designed for synthesis of broadband signals, with enhanced linearity and band flatness performances.

The TS86101G2B is manufactured using full Si bipolar technology. Due to its integrated input 4:1 MUX, this digital-to-analog converter enables the user to address data rates of only  $\frac{1}{4}$  of the effective sampling frequency (up to 350 Mbps input rate), facilitating its interface with state-of-the-art FPGAs, ASICs and DSPs.

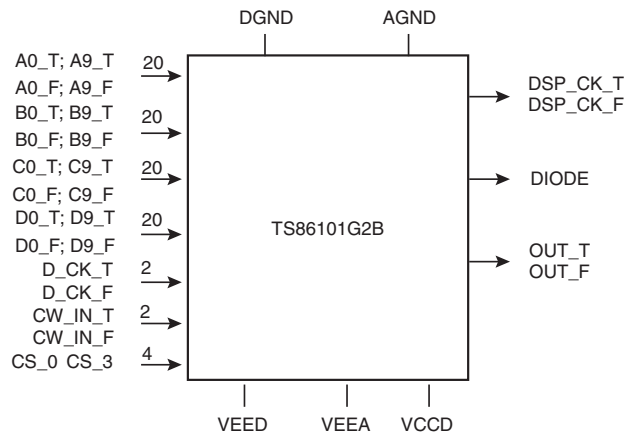
The device requires an input Data Ready clock for the data acquisition as well as an output DSP clock, used for synchronization with the DSP/FPGA/ASIC. This DSP clock is phase programmable thanks to the <CS\_0;CS\_3> 4-bit clock phase shift select function of the device.

The analog output is 2 V<sub>pp</sub> in differential mode or 1 V<sub>pp</sub> in single-ended mode and a diode pin is provided for die junction temperature monitoring.

**Table 5-1.** Description of Functions

Name	Function
V <sub>EEA</sub>	Analog power supply
V <sub>EED</sub>	Digital power supply
V <sub>CCD</sub>	Digital power supply
AGND	Analog ground
DGND	Digital ground
<A0_T:A9_T> <A0_F:A9_F>	Differential input data port A
<B0_T:B9_T> <B0_F:B9_F>	Differential input data port B
<C0_T:C9_T> <C0_F:C9_F>	Differential input data port C
<D0_T:D9_T> <D0_F:D9_F>	Differential input data port D
OUT_T,OUT_F	Differential analog output
D_CK_T, D_CK_F	Differential Data Ready clock inputs
DSP_CK_T DSP_CK_F	Differential DSP clock output
CW_IN_T CW_IN_F	Differential independent master clock input
<CS_0;CS_3>	Shift select for DSP clock (TTL)
DIODE	Die junction temperature monitoring
GA	Gain adjust (to be connected to the REF pin)

Figure 5-1. Device Pinout



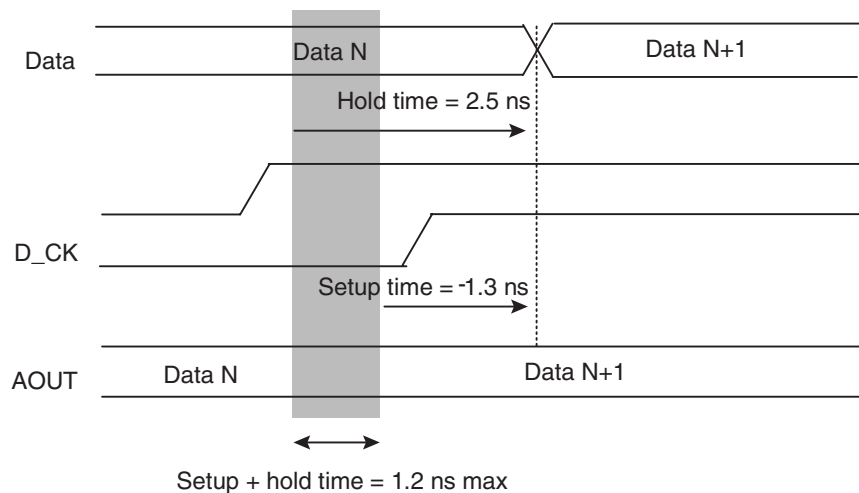
## 5.2 Registering the Input Data

The 4 × 10-bit differential digital input data patterns (port A: [Ai\_T, Ai\_F], port B: [Bi\_T, Bi\_F], port C: [Ci\_T, Ci\_F] and port D: [Di\_T, Di\_F]) are loaded in parallel into the first bank of master latches by the rising edge (hold mode) of the differential Data Ready input (D\_CK\_T, D\_CK\_F).

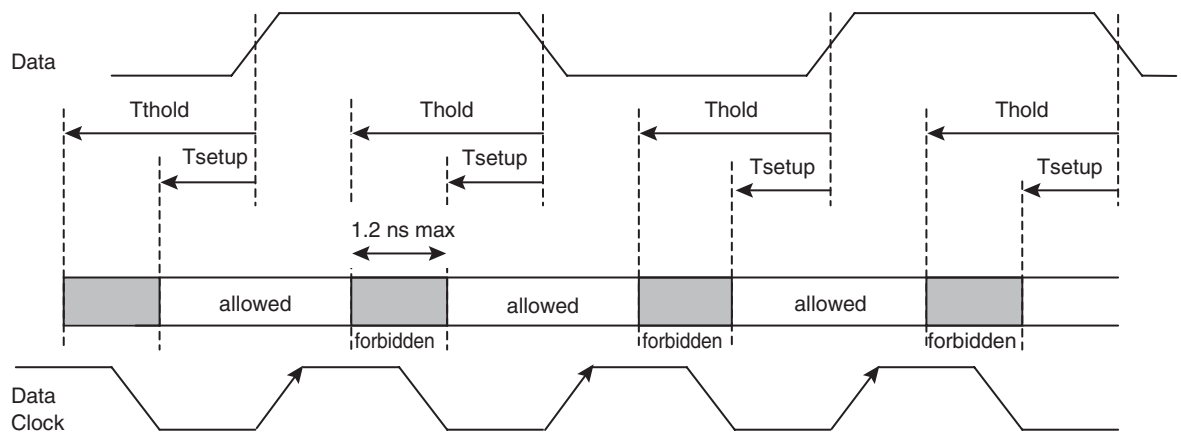
Note: The Data Ready duty cycle may vary in accordance with the setup and hold times. The digital data and Data Ready input rates are equivalent to one fourth of the CW\_IN master clock frequency. The Data Ready rising edge must be (approximately) centered within the digital data input pulse – a minimum setup and hold time between the data and Data Ready must be observed to ensure enough margin for the input data time jitter and the different systematic skews amongst the data (trace lengths, package skew, etc.).

The registered input data is latched in the second bank of master/slave latches by the rising edge of the CW\_IN master clock *divided by 4*. For correct operation, a phase relation between Data Ready and the CW\_IN master clock input must be respected (see Figure 5-2).

Figure 5-2. Data or Data Ready (D-CK) Timing



**Figure 5-3.** Data to Data Clock Forbidden Area

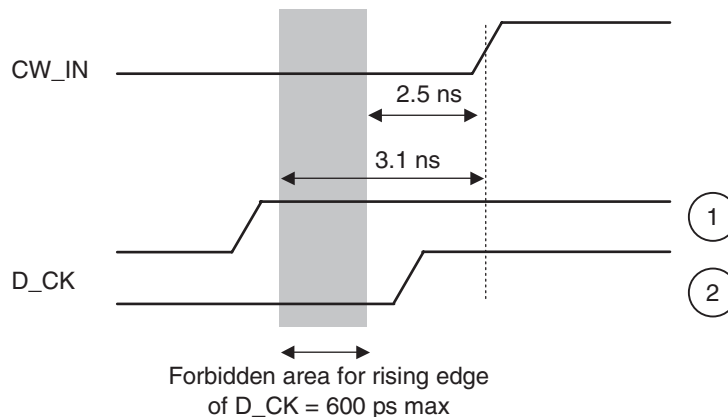


### 5.3 Phase Relationship Between Data Ready and CW\_IN Clock Input

There is a forbidden time range in the phase relation between Data Ready and the CW\_IN master clock. This forbidden zone occurs when active rising edges of CW\_IN and Data Ready do not comply with the setup and hold times (see Figure 5-4 on page 22). Within this forbidden zone, the data is stored in the second bank of master latches at the time when the first outputs of slave latches switch (acquisition of next incoming data). Within this critical time range of 600 ps, data pattern throughput transmission errors may occur.

To satisfy setup and hold times, the phase of the Data Ready input (D\_CK\_T to D\_CK\_F) can be adjusted by choosing one of the 16 DSP clock shift positions (assuming that the DSP providing the data and Data Ready signals to the MUXDAC is clocked by the MUXDAC DSP clock's output signal).

**Figure 5-4.** Data Ready (D\_CK) to CW\_IN Master Clock Timing



If the D\_CK clock edge occurs within the forbidden zone, there is an ambiguity on the data to be transferred from the first to the second bank of latch (data N or data N + 1).

Case 1:

If the D\_CK clock edge occurs before the forbidden zone, data N will be transferred internally from the first to the second bank of latch (see [Figure 8-2 on page 30](#)).

Case 2:

If the D\_CK clock edge occurs after the forbidden zone, data N +1 will be transferred internally from the first to the second bank of latch (see [Figure 8-2 on page 30](#)).

### 5.3.1 Tuning the DSP Clock Output Phase

The DSP clock output phase may be tuned over a range of 3.1 ns in 15 discrete steps of 200 ps each, plus a propagation delay of 2.1 ns (the 2.10 ns value is an absolute timing value measured from CW\_IN input ball to DSP Clock output ball), by correctly setting the 4-bit address input CS\_0, CS\_1, CS\_2 and CS\_3 from 0000 to 1111:

- 0000: 2.1 ns + 0
- 0001: 2.1 ns + 200 ps
- ...
- 1111: 2.1 ns + 3.1 ns

### 5.3.2 Analog Output Data Switching Information

The analog output data changes on the CW\_IN master clock's rising edge, after one clock cycle pipeline delay, plus TOD (output propagation delay). TOD includes the following:

- Propagation time delays of the packaging accesses
- The DAC's core internal conversion time and other internal propagation delays

The typical value of TOD is 3.7 ns, assuming a 50Ω // 2 pF load.

## 6. Main Features of the TS86101G2B

### 6.1 Input MUX

The 4:1 integrated input MUX of the TS86101G2B provides the user with the capacity to apply an input data rate four times lower than the effective sampling frequency used:

$$\text{Data rate} = F_s/4 = F(\text{DSP\_CK}) = F(\text{D\_CK})$$

Where:

- F(DSP\_CK) is the frequency of the DSP output clock
- F(D\_CK) is the frequency of the Data Ready input clock

Since this input MUX is not programmable, all four ports must be used for proper operation of the DAC.

## 6.2 Power-up Asynchronous Reset/Synchronization of Several TS86101G2B Devices

A power-on asynchronous reset is integrated on the MUXDAC. It is active during the  $V_{EED}$  ramp-up, (up to 50% of its final steady-state value –  $V_{EEA}/V_{EED} < -2.5V$ ).

To make sure that initialization is effective, the clock should not toggle before  $V_{EED}/V_{EEA}$  exceed 90% of their final value.

This asynchronous reset allows correct initialization of the divide/4 timing circuitry that drives the 4:1 MUX, therefore providing synchronous DSP output clock signals (DSP\_CK\_T, DSP\_CK\_F) and synchronous analog output signals between multiple DACs.

During the power-up reset phase, the applied (CW\_IN\_T, CW\_IN\_F) master clock should not toggle.

For initialization, three clock input configurations are authorized:

- Differential clock input: the master clock can start indifferently at a logical high or low.
- Single-ended clock input on CW\_IN\_T: the master clock must be at a logical high during reset and start with a falling edge.
- Single-ended clock input on CW\_IN\_F: the master clock must be at a logical low during reset and start with a rising edge.

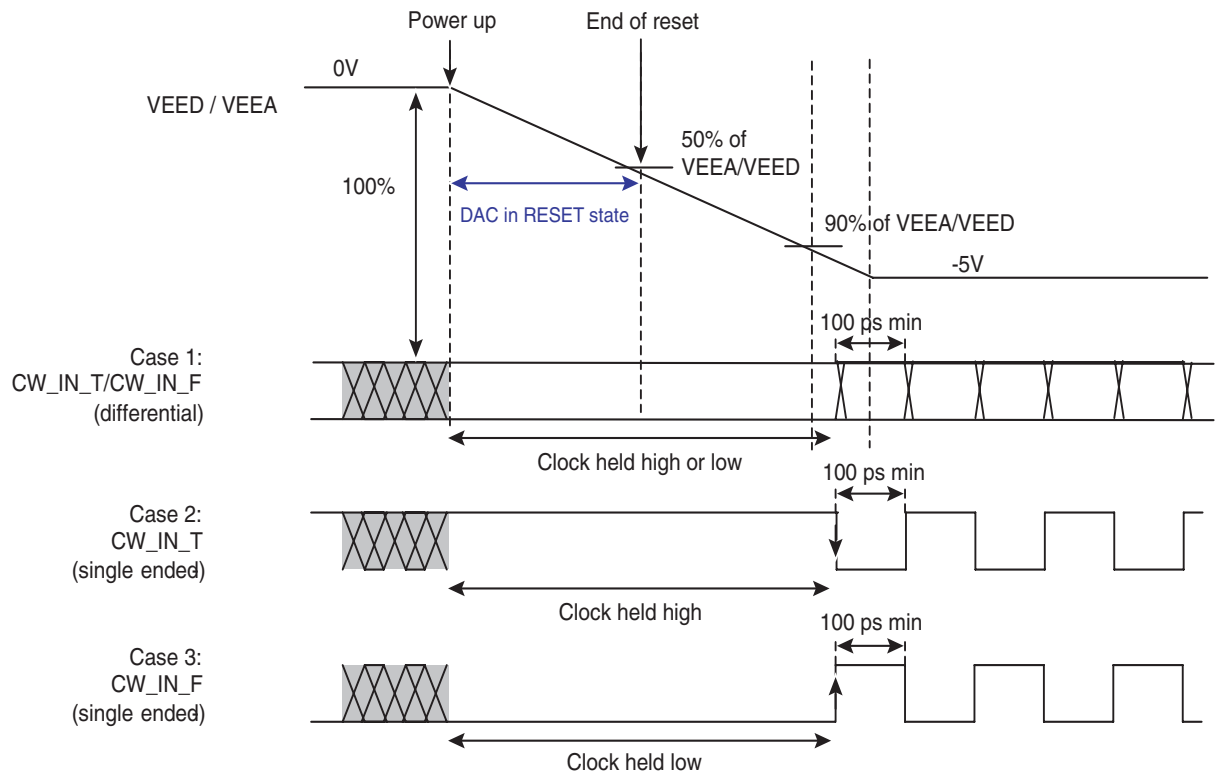
In all cases, the first pulse width of the master clock should last at least 100 ps and should not toggle in an undetermined way in order to avoid metastability of the clock.

For DSP systems that require several MUXDACs to be synchronized, the following design and protocol rules apply:

1. The MUXDACs must be powered-up under DSP executive control, with their clocks kept inactive. If used in differential mode (recommended), the clocks should be previously set to either a high or low state, and in any case the clocks should not be toggling.
2. A delay equalling the settling time of the power supplies (time until they reach at least 90% of their steady state) must be respected before proceeding to step 3.
3. The MUXDAC clocks can then be commanded to their active state. In order to reduce the probability of clock meta-stability, the first pulse should last at least 100 ps and should not toggle in an undetermined way.
4. All MUXDAC clock paths within a given DSP should be designed according to the standard high-speed design rules.

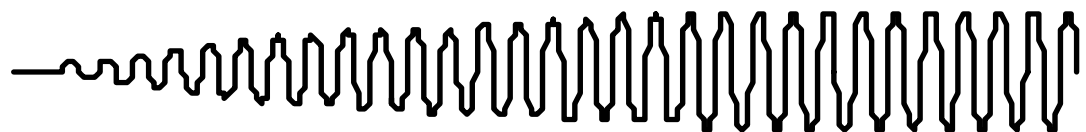


**Figure 6-1.** Synchronization of Multiple TS86101G2B Devices



- Notes:
1. A counter can be used to determine when the clock can be enabled after power-up.
  2. If the clock starts as illustrated below, there is no guarantee that the DACs will start synchronously (they may start on different edges of the clock). It is essential that the clock starts with clean transitions.

**Figure 6-2.** Clock Transition at Power-up



### 6.3 Programmable DSP Clock

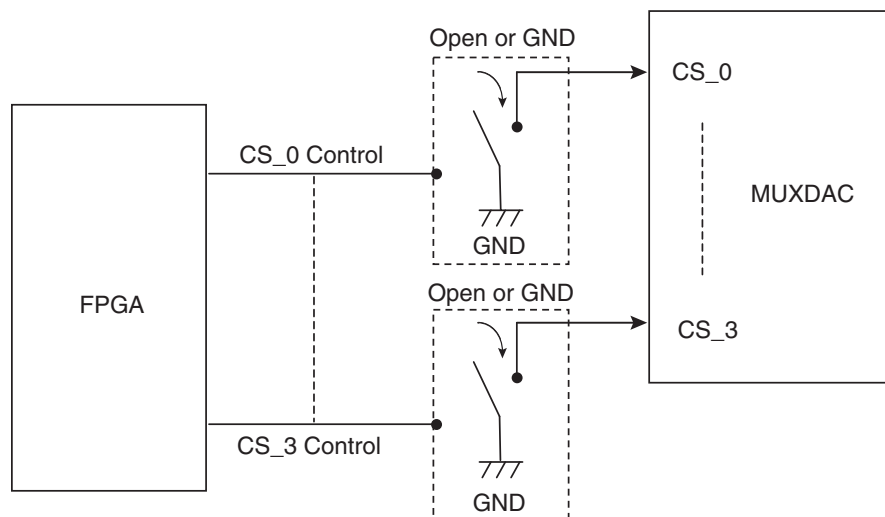
For correct synchronization of the MUXDAC with the DSP/FPGA/ASIC circuit intended to send the digital data to the MUXDAC, a DSP output clock is provided by the MUXDAC.

To finely synchronize the two devices (MUXDAC and DSP/FPGA/ASIC), a programmable delay can be applied to the DSP clock. This delay is controlled via the CS\_0, CS\_1, CS\_2 and CS\_3 bits and has a range of 3.1 ns in 200 ps discrete steps.

Please also refer to [“Functional Description” on page 20](#).

The [CS\_0;3] bits are TTL signals (1 = TTL high, 10 kΩ or left open, 0 = TTL low or ground via 10Ω or less) but can also be implemented as shown in [Figure 6-3 on page 26](#).

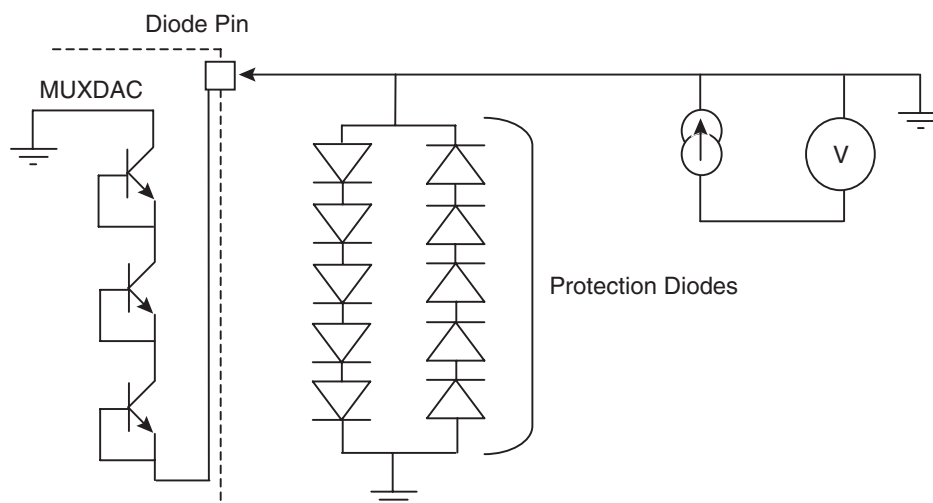
**Figure 6-3.** Synchronization of the MUXDAC with DSP/FPGA/ASIC Circuit



### 6.4 Diode Pin for Die Junction Temperature Monitoring Function

The diode pin is provided for the die junction temperature monitoring function.

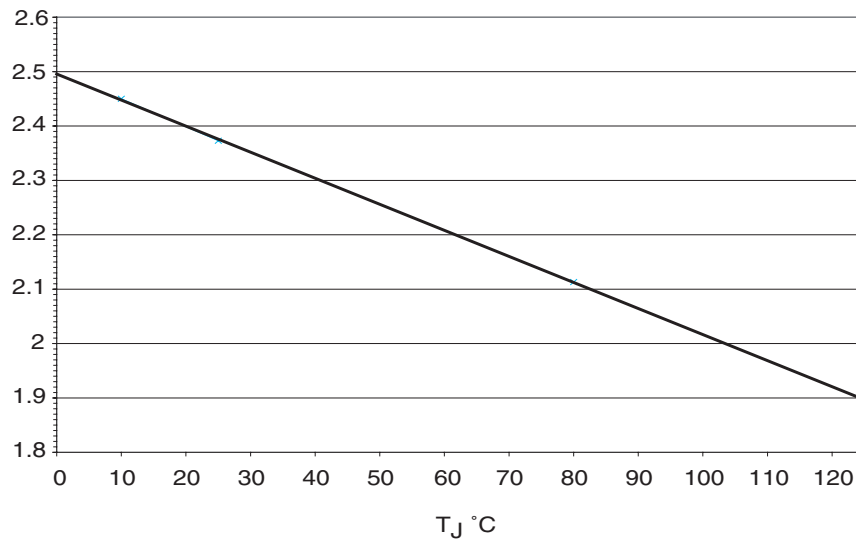
**Figure 6-4.** Die Junction Temperature Monitoring



For a given forced current in the diode pin, the voltage across the diode-mounted transistor is linearly dependent on the temperature. Since the characteristic of the diode may vary from one device to another, the voltage across the diode must first be measured to obtain a junction temperature.

Once the diode-mounted transistor is measured,  $V_{be}$  values according to the junction temperature at  $I = 1 \text{ mA}$  are given in [Figure 6-5 on page 27](#).

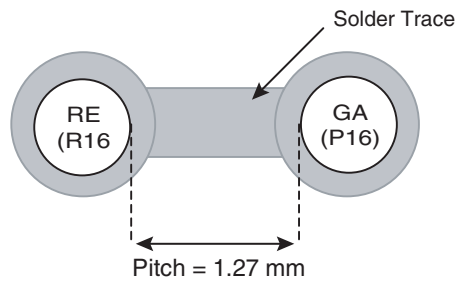
Figure 6-5. Vdiode at I = 1 mA



### 6.5 GA Pin

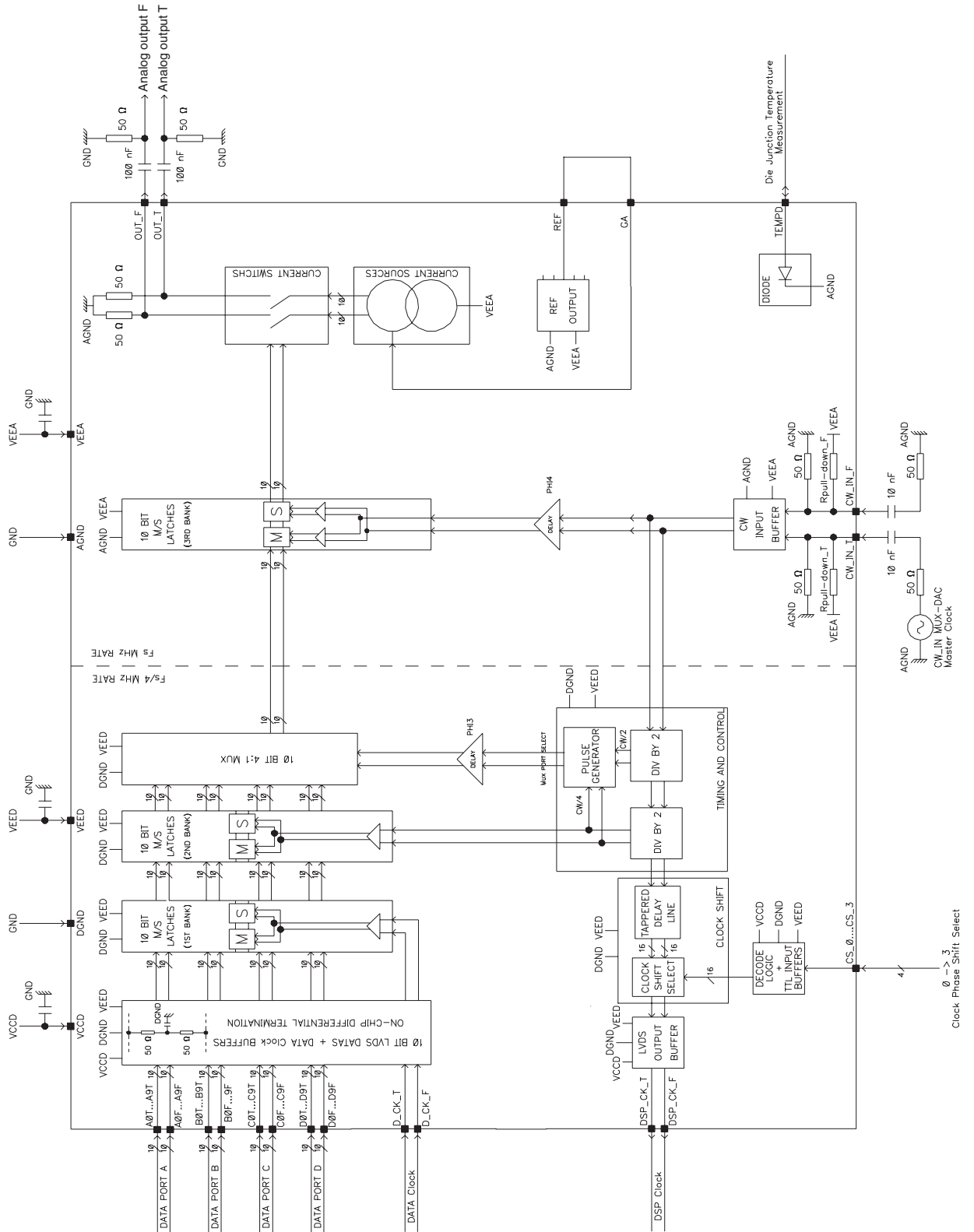
The GA pin (P16) must be connected to the REF pin (R16) with the shortest possible trace between the two balls/columns as depicted in [Figure 6-6](#).

Figure 6-6. GA Pin



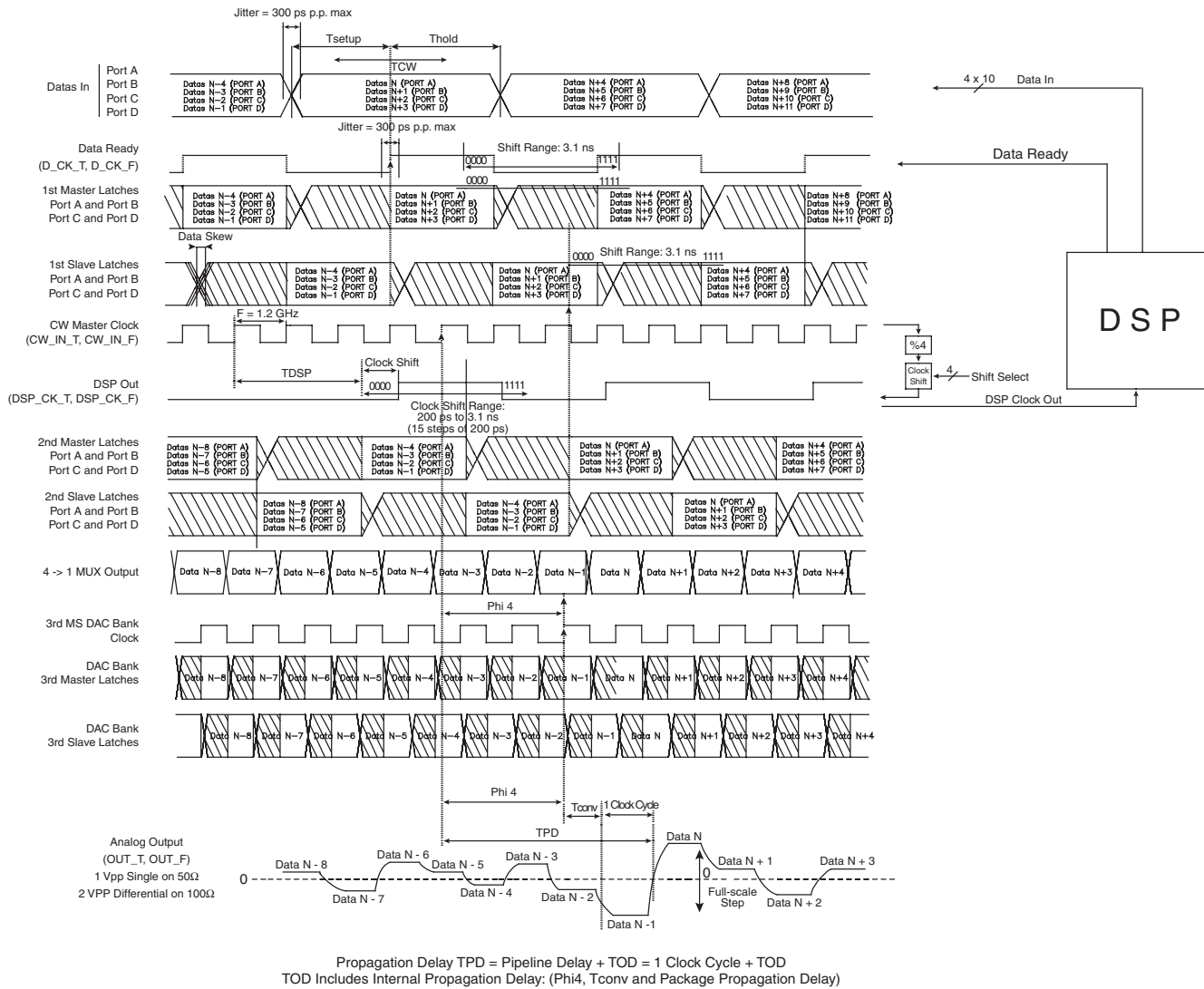
## 7. Block Diagram

Figure 7-1. Block Diagram



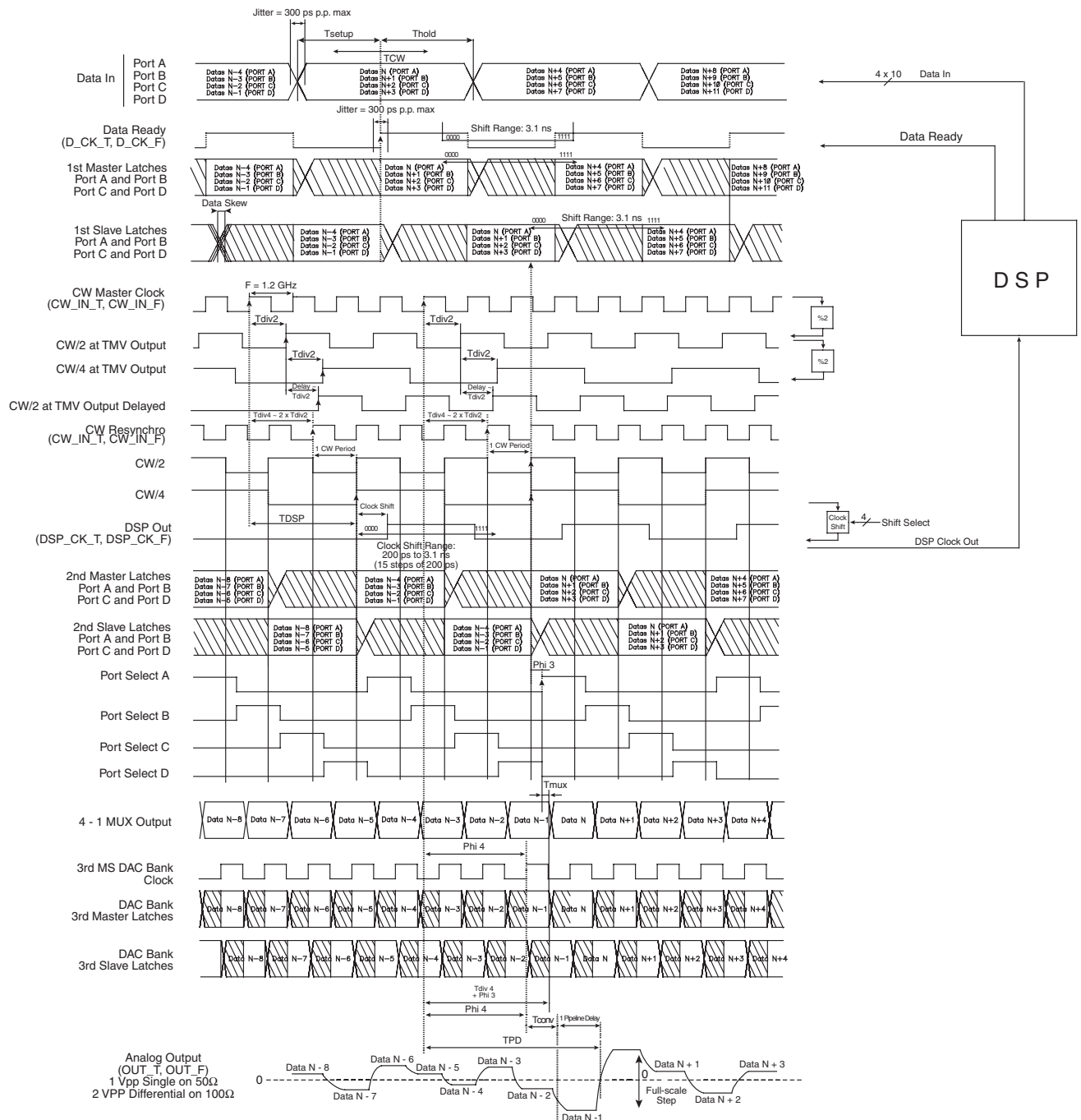
# 8. Timing Diagram

Figure 8-1. Simplified Timing Diagram



Note: All timing parameters are defined under "Definitions of Terms" on page 35.

Figure 8-2. Detailed Timing Diagram



Propagation Delay  $T_{PD} = \text{Pipeline Delay} + \text{TOD} = 1 \text{ Clock Cycle} + \text{TOD}$   
 TOD Includes Internal Propagation Delay; ( $\Phi_{i4}$ , DAC Core Conversion Time and Package Propagation Delay)

Note: All timing parameters are defined under "Definitions of Terms" on page 35.

## 9. Equivalent Input/Output Schematics

Figure 9-1. Equivalent Digital Input Circuit and ESD Protections (Input Data and Data Ready Input Clock)

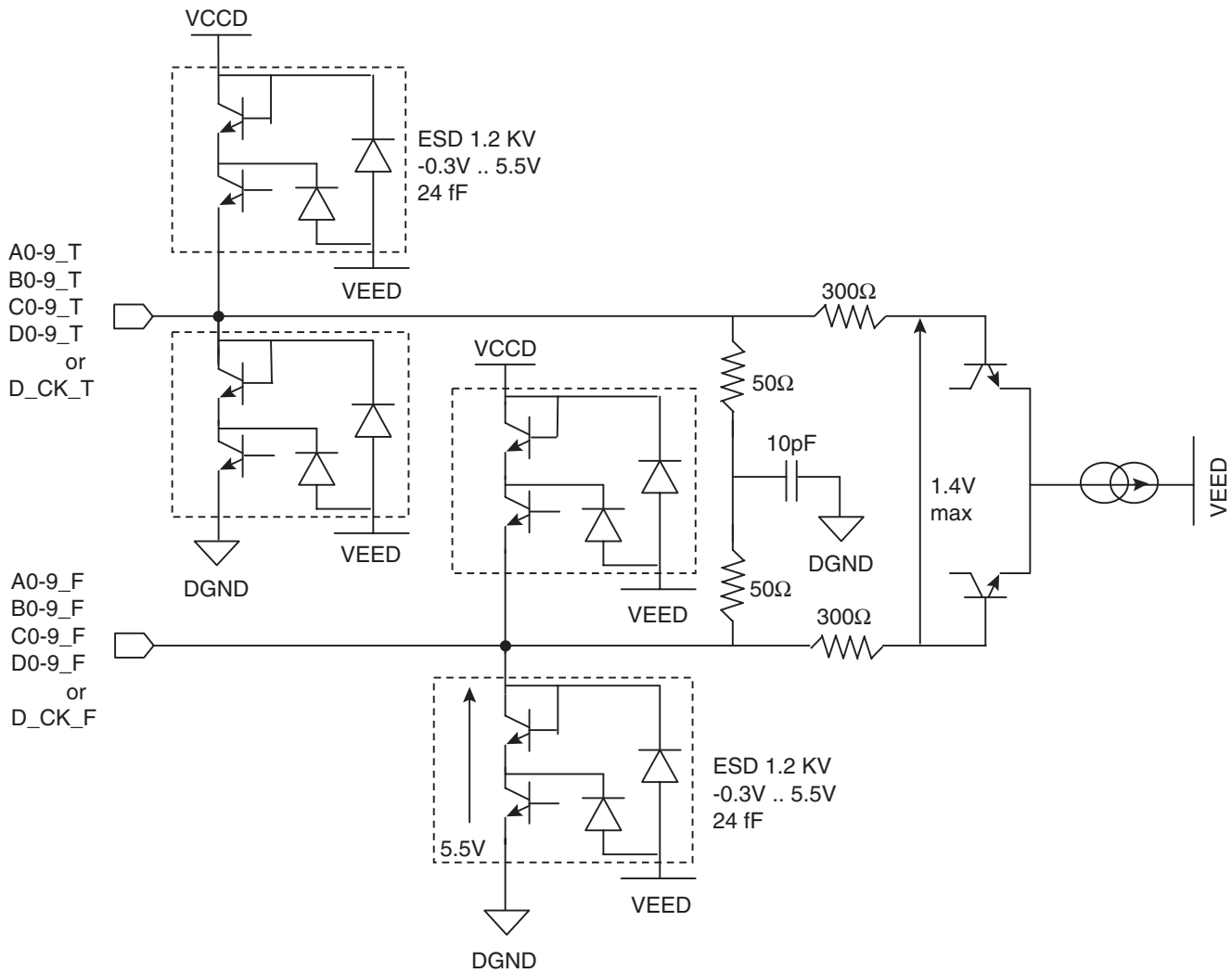


Figure 9-2. Equivalent CW\_IN Master Input Clock Circuit and ESD Protections

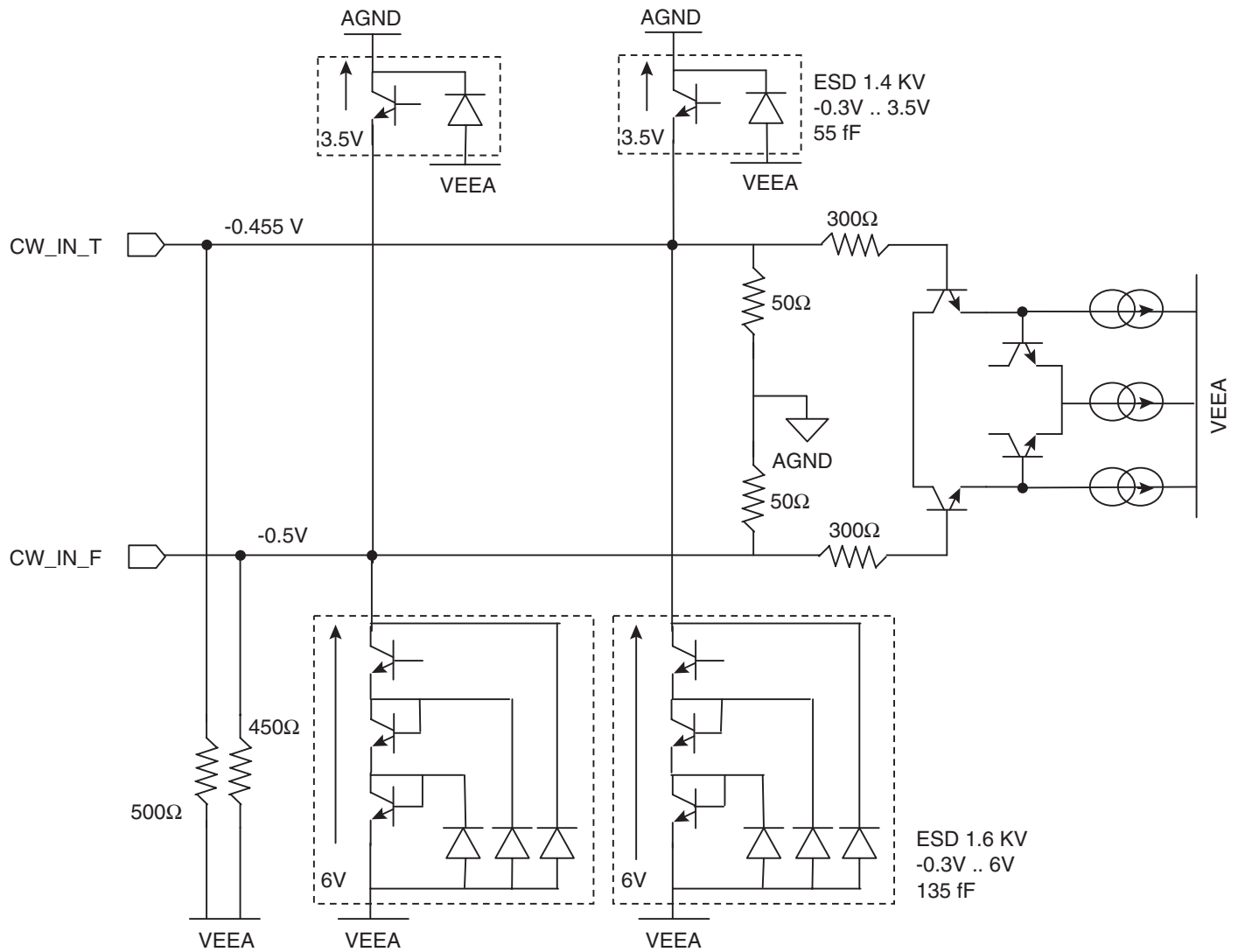




Figure 9-3. Equivalent DSP Clock Output Buffer and ESD Protections

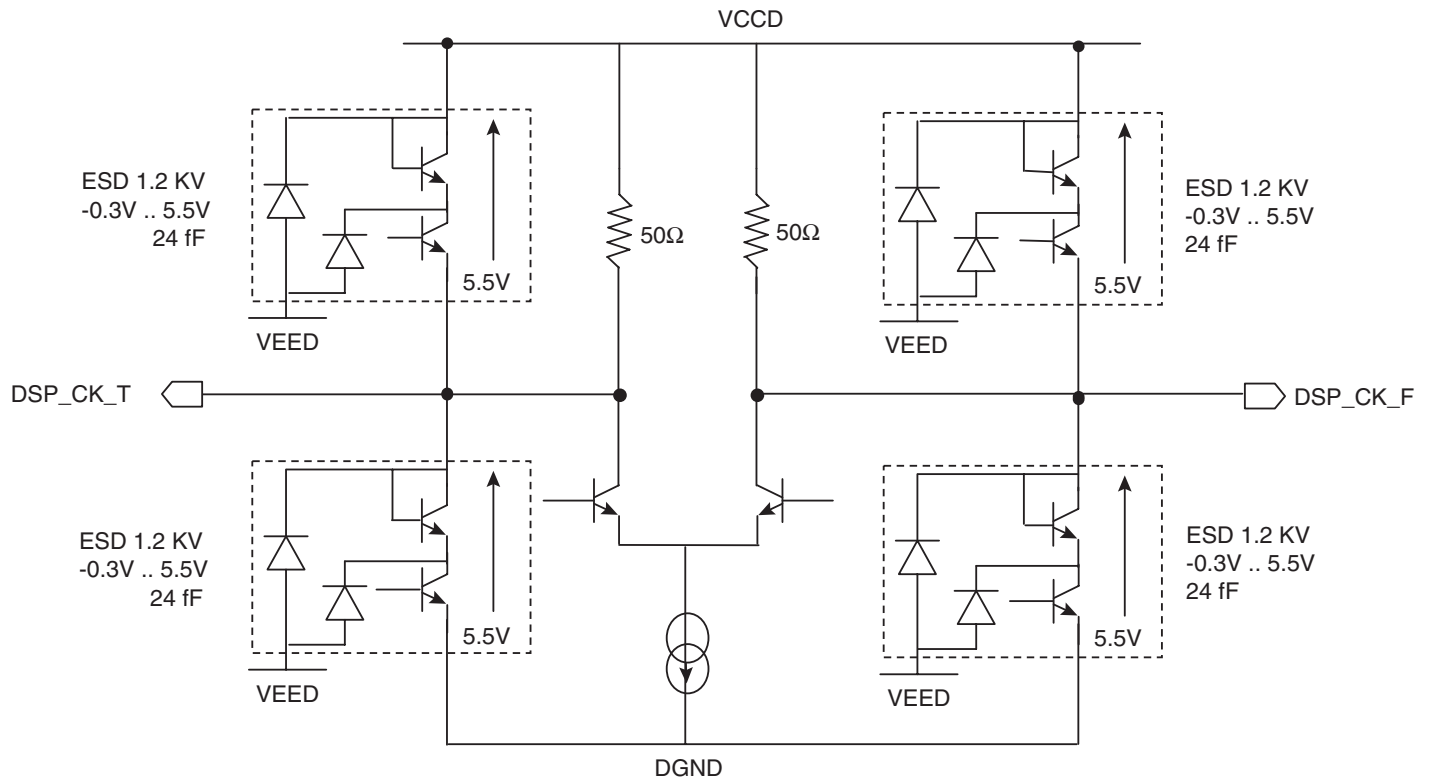
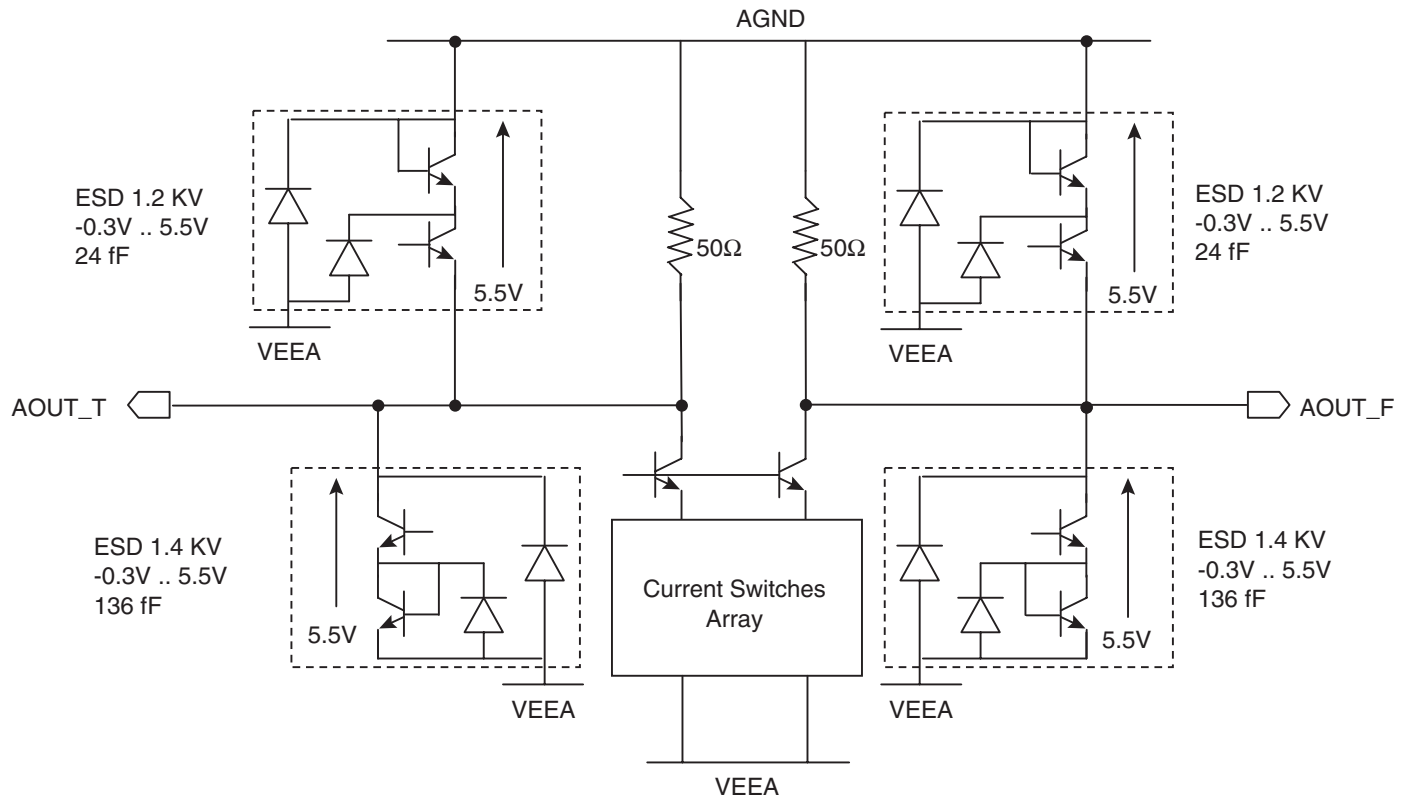


Figure 9-4. Equivalent DAC Analog Output and ESD Protections



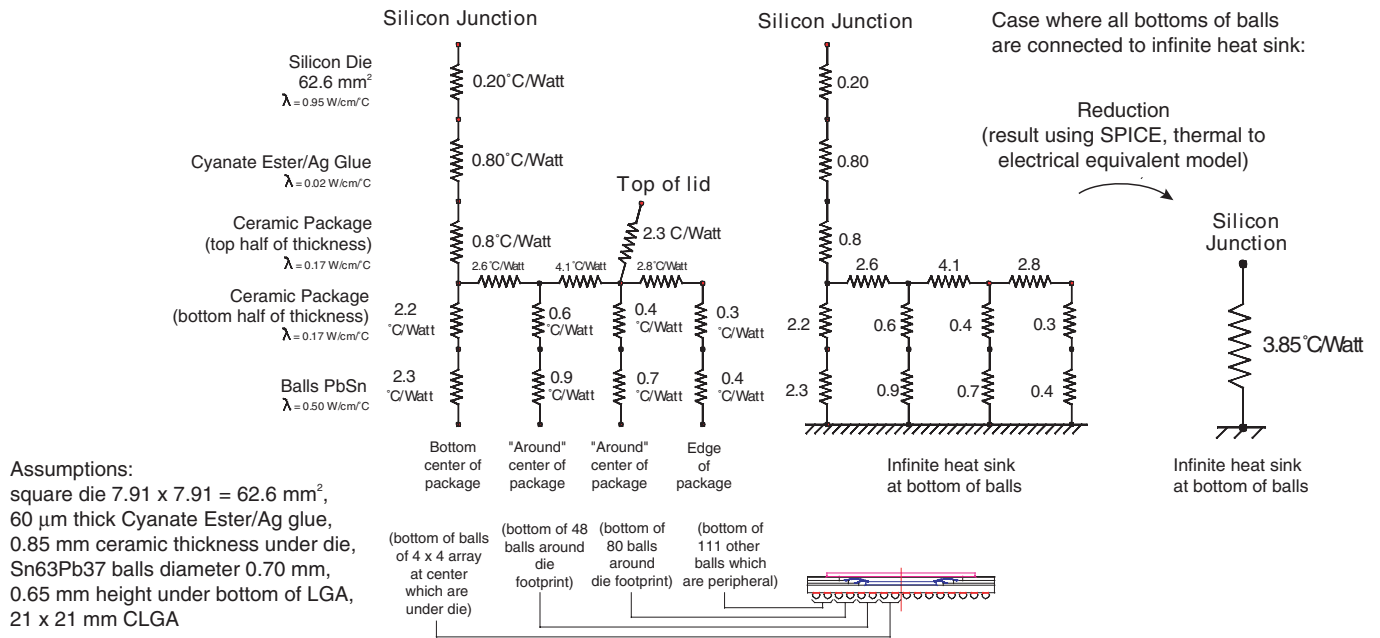
## 10. Definitions of Terms

**Table 10-1.** Definitions of Terms

Abbreviation	Definition	Description
(ACPR)	Adjacent Channel Power Ratio	The ratio in dB between the power in the adjacent channel and the power in the channel carrying the modulated signal
(DNL)	Differential Non-linearity	The maximum deviation in the output step size from the ideal value of one least significant bit (LSB). A DNL of $-1$ LSB means that a DAC converter guarantees the transfer function is monotonic
(FSR)	Full-scale Range	The maximum difference between the highest and lowest input levels for which various device performance specifications prevail, unless otherwise noted
(IMD)	Inter-modulation Distortion	The two tones intermodulation (IMD) rejection is the ratio of either output tone to the worst intermodulation products. The output tone levels are at $-6$ dB full-scale
(INL)	Integral Non-linearity	The maximum deviation of the output transfer curve at each code from the ideal one after the gain and offset error are corrected
(NPR)	Noise Power Ratio	The NPR is measured to characterize the DAC's capacity to synthesize a broadband signal. When using a notch-filtered broadband white-noise DAC input pattern, the Noise Power Ratio is defined as the ratio of the average out-of-notch to the average in-notch power spectral density magnitude at the DAC's output spectrum
(SFDR)	Spurious Free Dynamic Range	The ratio expressed in dB of the RMS signal amplitude to the RMS value of the next highest spectral component (peak spurious spectral component) measured in the frequency band DC to $F_{clk}/2$ . SFDR is the key parameter for selecting a converter to be used in a frequency domain application. It may be reported in dBc (degrades as signal levels are lowered) or in dBFS (always full-scale when related back to the converter)
(SINAD)	Signal-to-Noise and Distortion Ratio	The ratio expressed in dB of the RMS signal amplitude to the RMS sum of all other spectral components, including the harmonics except DC
(SNR)	Signal-to-noise Ratio	The ratio expressed in dB of the RMS signal amplitude to the RMS sum of all other spectral components excluding the first five harmonics
(THD)	Total Harmonic Distortion	The ratio expressed in dBc of the RMS sum of the first 10 harmonic components, to the RMS value of the measured fundamental spectral component
TDSP		The time delay between the rising edge of the CW_IN master clock and the active DSP clock rising edge for a clock shift of 0000
THold	Hold Time	The time difference between the rising edge of the differential Data Ready input (zero crossing) and a point of change of the digital input data (zero crossing of differential input)
TPD/TOD	Output Propagation Delay	The analog output propagation delay. Measured between the rising edge of the differential CW_IN clock input (zero crossing point) and the zero crossing point of a full-scale analog output voltage step. TPD corresponds to one CW_IN clock cycle pipeline delay plus an internal propagation delay (TOD) including package access propagation delays and internal (on-chip) delays such as clock input buffers and DAC conversion times
TSetup	Set-up Time	The time difference between the point of change of the digital input data (zero crossing of differential input) and the rising edge of the differential data ready input (zero crossing)
(VSWR)	Voltage Standing Wave Ratio	The VSWR corresponds to the DAC output insertion loss due to output power reflection. As a reminder, a VSWR of 1.12 corresponds to a 20 dB return loss (99% power transmitted and 1% reflected) and therefore to a 0.0436 dB transmission loss

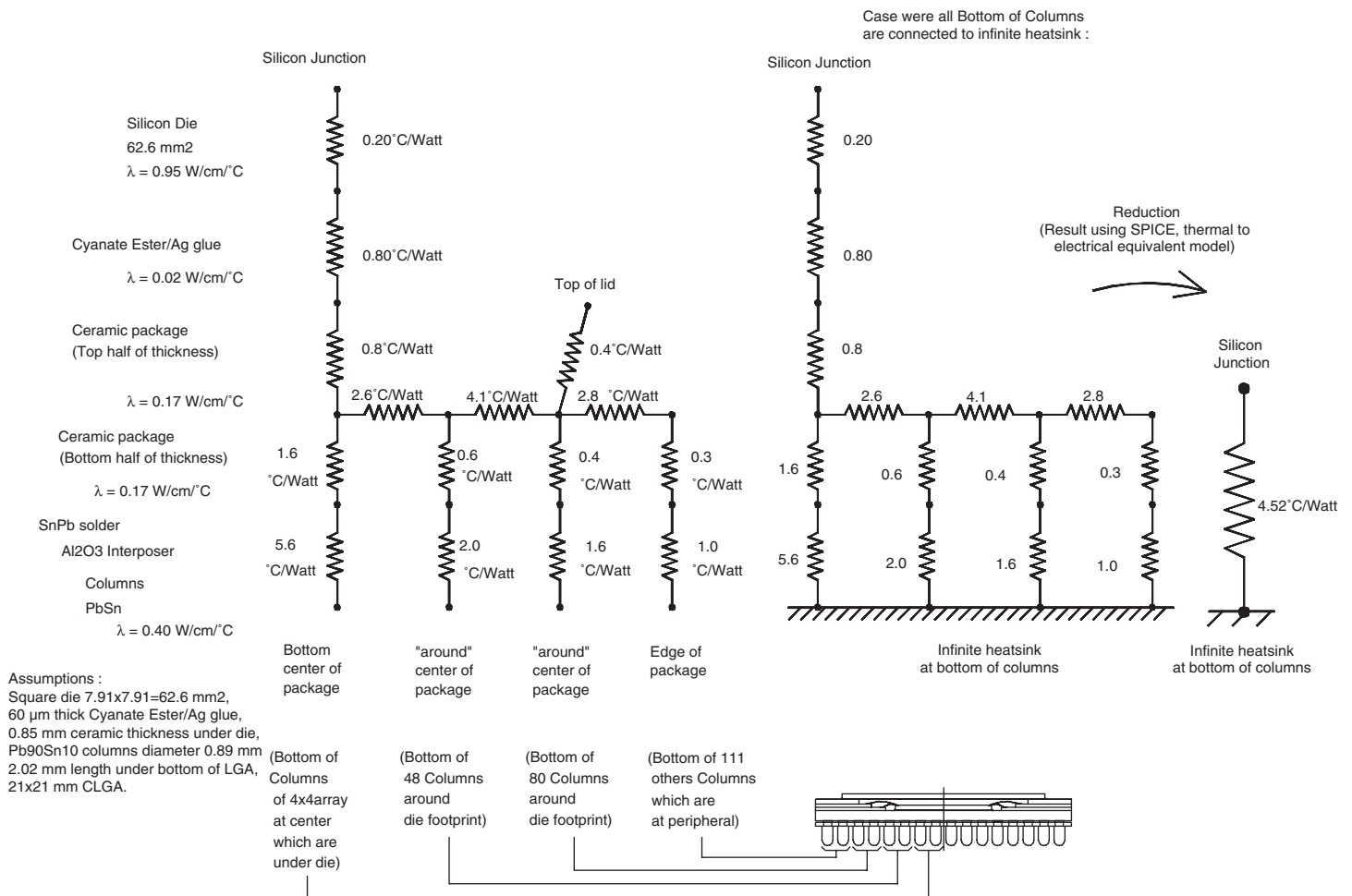
# 11. Thermal and Moisture Characteristics

Figure 11-1. Simplified Thermal Model for CBGA 255 Package



- Notes:
1. Typical values, assuming that the power dissipation is uniform over 25% of the die's top surface, are extracted from ANSYS® thermal simulation.
  2. CBGA 255 package is hermetic.

Figure 11-2. Simplified Thermal Models for CI-CGA 255 Package



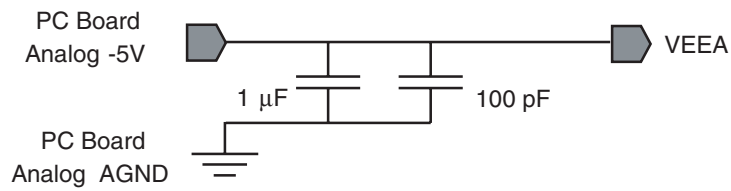
- Notes:
1. Typical values, assuming that the power dissipation is uniform over 25% of the die's top surface, are extracted from ANSYS thermal simulation.
  2. CI-CGA 255 package is hermetic.

## 12. Applying the TS86101G2B MUXDAC

### 12.1 Accessing Power Supplies

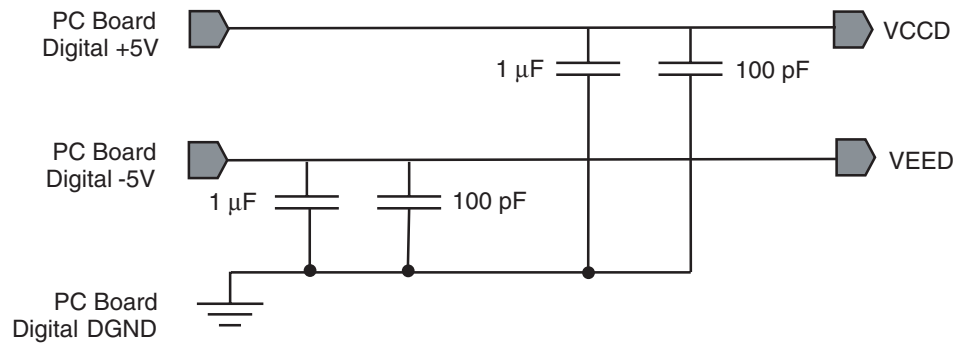
The TS86101G2B MUXDAC features three different power supplies ( $V_{CCD}$ ,  $V_{EED}$  and  $V_{EEA}$ ) as well as two different ground planes (analog ground plane AGND and digital ground plane DGND). We highly recommend that the analog and digital planes be fully separated (both at board level and externally).

**Figure 12-1.**  $V_{EEA}$  Bypassing and Grounding Scheme



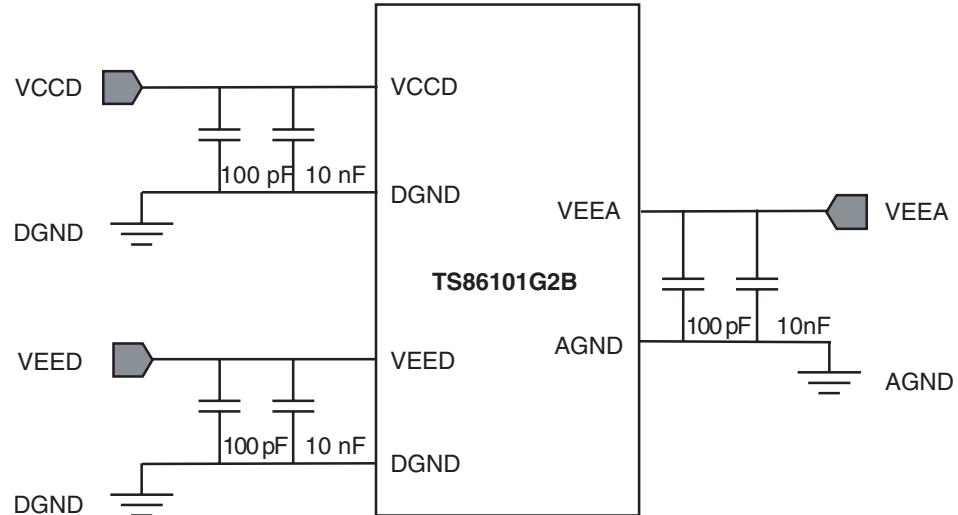
Note: The 1  $\mu$ F and 100 pF capacitors must be placed as close as possible to the board connectors.

**Figure 12-2.**  $V_{EED}$  and  $V_{CCD}$  Bypassing and Grounding Scheme



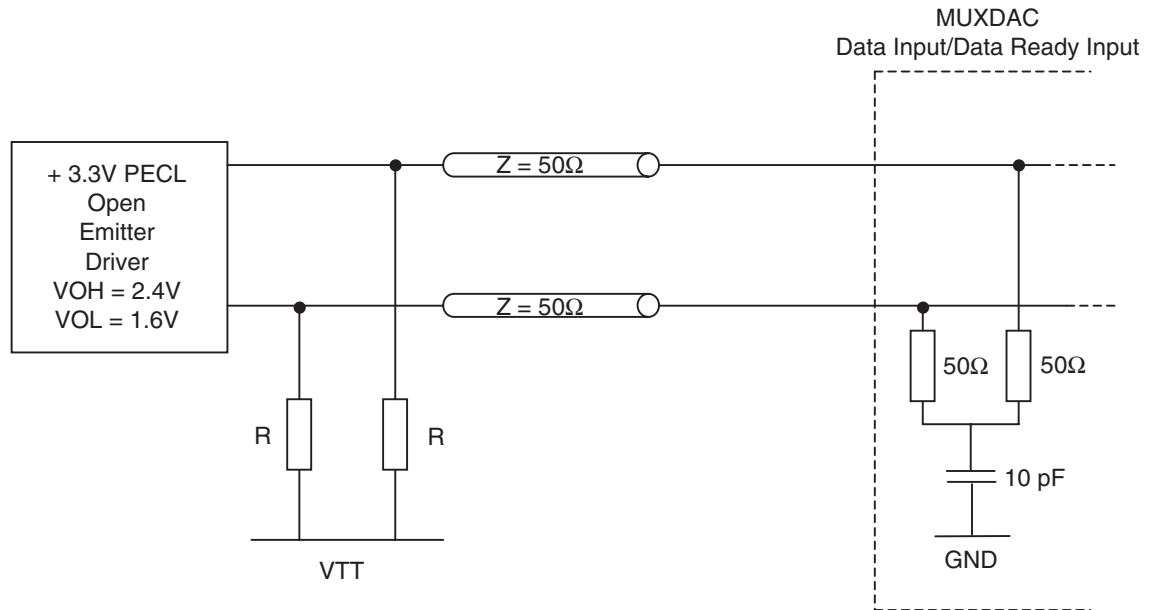
Note: The 1  $\mu$ F and 100 pF capacitors must be placed as close as possible to the board connectors.

**Figure 12-3.** Decoupling Scheme of Power Supplies



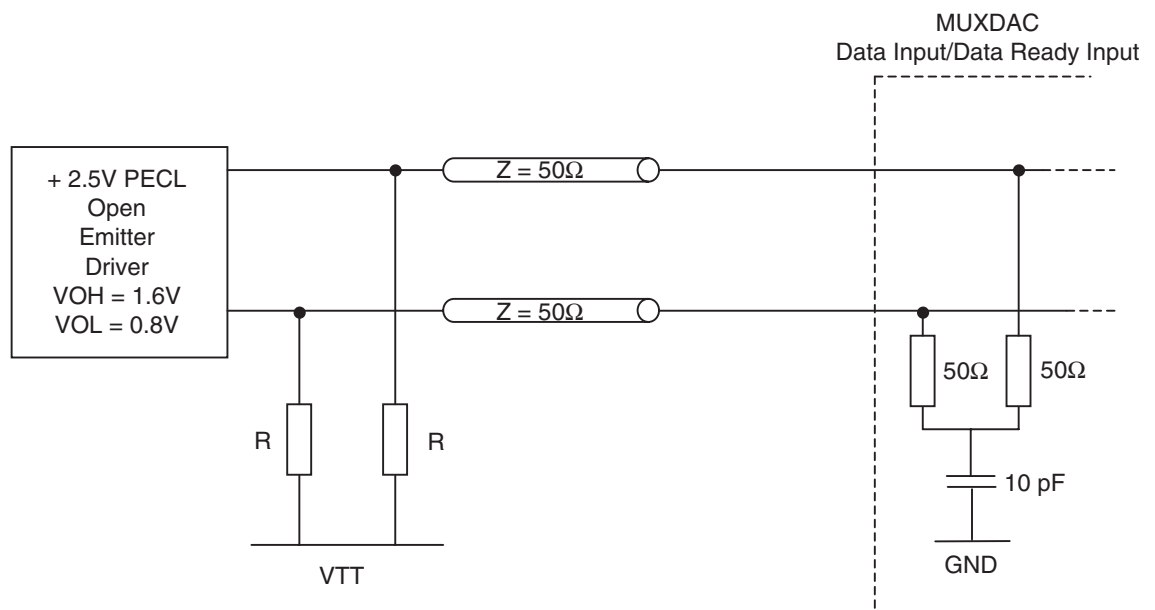
## 12.2 Digital Inputs and Data Ready Signal Implementation

Figure 12-4. Differential 3.3V PECL



Note: Recommended values for R and  $V_{TT}$ :  
 $V_{TT} = \text{GND}$ ,  $R = 120$  to  $200\Omega$   
 $V_{TT} = 1V$ ,  $R = 50\Omega$   
 Rule of thumb for determining R and  $V_{TT}$ :  $(V_{OL}-V_{TT})/R > \text{Swing}/100$

Figure 12-5. Differential 2.5V PECL



Note: Recommended values for R and  $V_{TT}$ :  
 $V_{TT} = \text{GND}$ ,  $R = 50\Omega$

Figure 12-6. LVDS

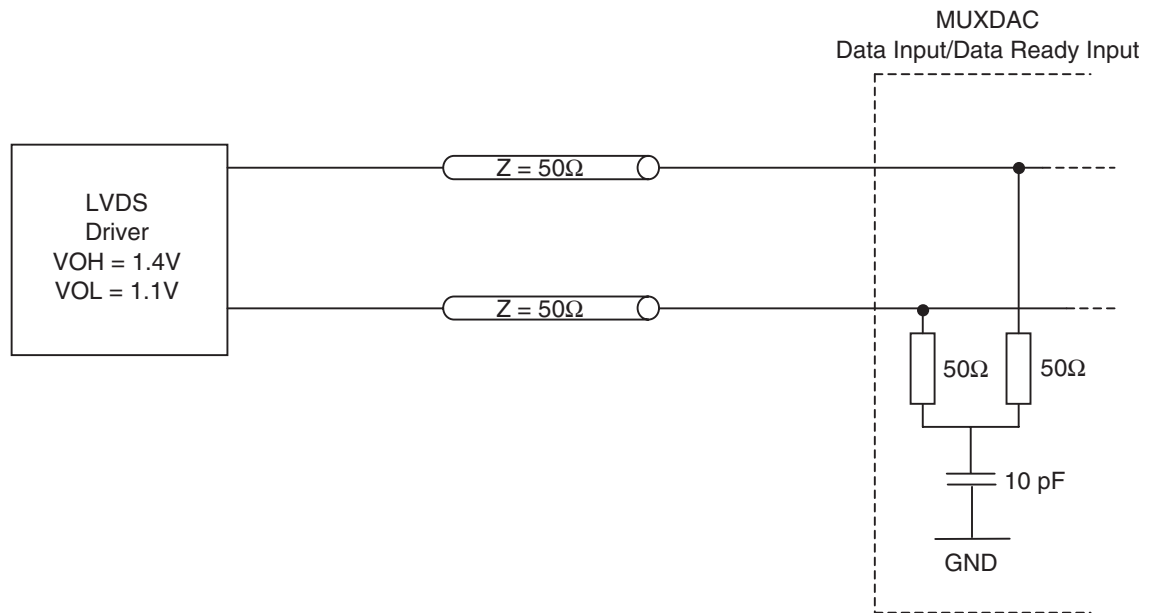
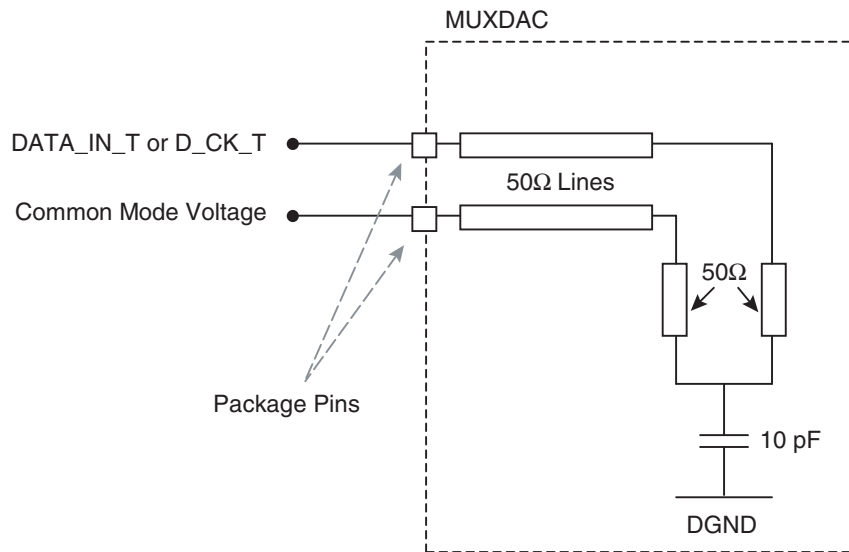


Figure 12-7. Single-ended Implementation of DATA\_IN and Data Ready Inputs



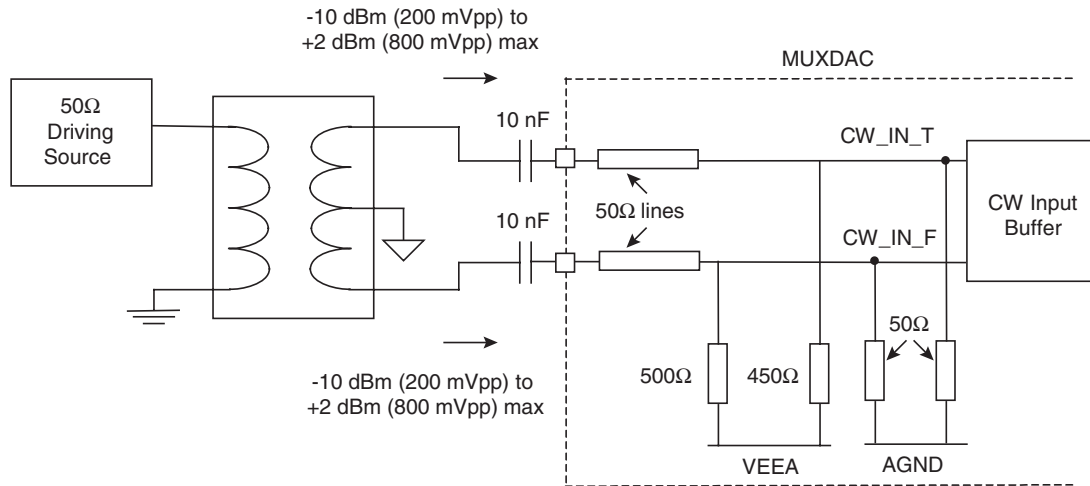
The TS86101G2B MUXDAC digital input and Data Ready input signals provide PECL and LVDS level formats in differential mode. When used in single-ended mode, the associated *false* signal must be tied to the common mode voltage of the *true* signal, as shown in [Figure 12-7](#).



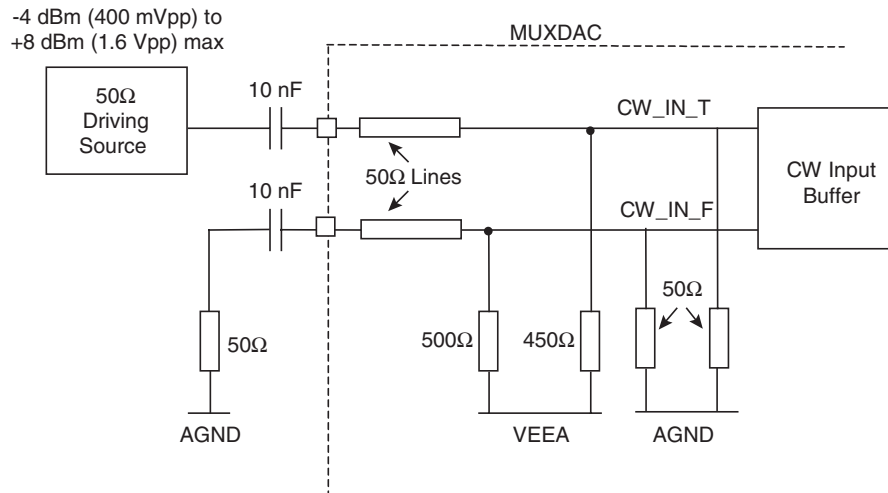
### 12.3 CW\_IN Master Clock Implementation

In order to allow for any ECL/PECL/LVDS differential input levels, the CW\_IN master input clock must be AC-coupled through 10 nF capacitors (for information only) as shown in Figure 12-8.

**Figure 12-8.** CW\_IN Master Input Clock Implementation in AC-coupled Differential Mode



**Figure 12-9.** CW\_IN Master Input Clock Implementation in AC-coupled Singled-ended Mode



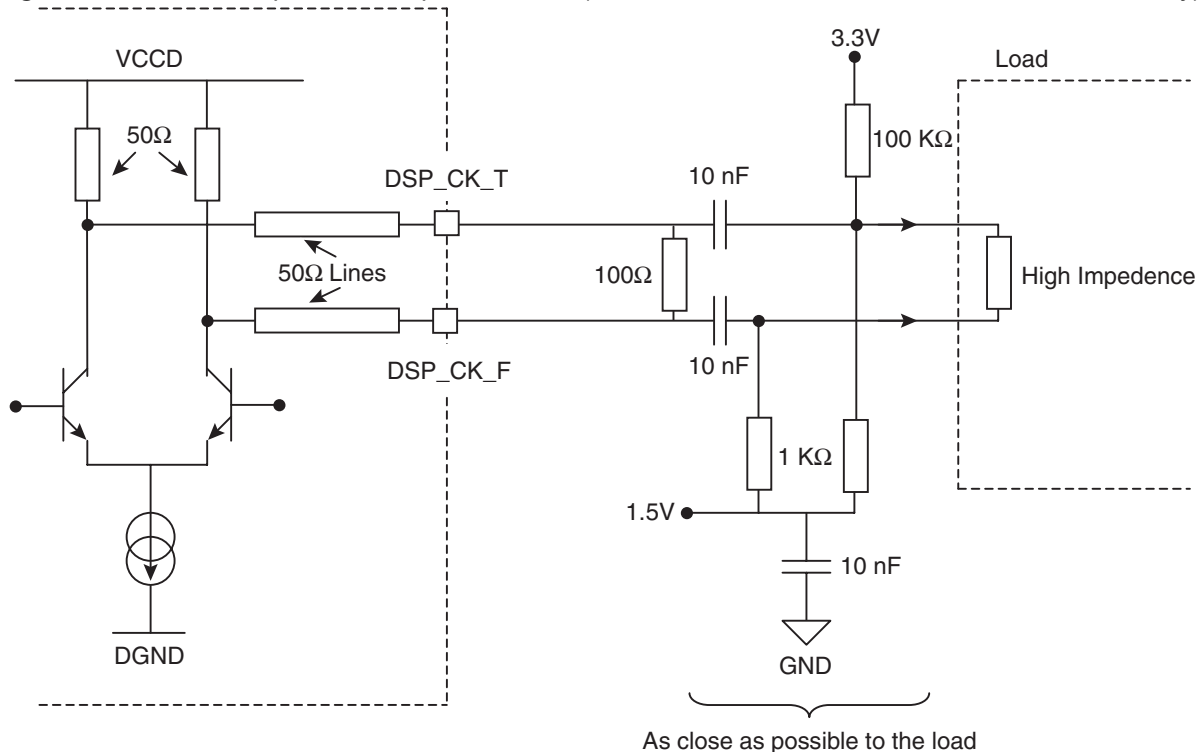
### 12.4 DSP Output Clock Implementation

In order to make the DSP output clock compatible with standard differential levels such as LVDS and PECL, the signals must be AC-coupled with 10 pF capacitors and used with pull-down resistors to ensure appropriate biasing, as shown in the following three figures.

Three configurations are depicted:

- The load has a high impedance input buffer
- The load has a 100Ω differential buffer
- The DSP\_CLK is sent to the load via a driver

Figure 12-10. DSP Output Clock Implementation (General Case – Values Given For Information Only)



- Notes:
1. The 100Ω differential resistor is required for impedance matching of the output buffer of the MUXDAC. It must be placed right after the MUXDAC buffer and not at the end of the line (i.e. close to the load) because of the biasing resistors used after the AC coupling capacitors (it would change the biasing).
  2. The 100Ω differential resistor, the AC coupling capacitors and the resistors used for the biasing should all be placed as close as possible to the load.
  3. Even without 100Ω differential resistor, the impedance of the output buffer is sufficient. In that case the swing of DSP output clock is twice larger and common mode remains unchanged.

Figure 12-11. DSP Output Clock Implementation (General Case, Values Given for Information Only)

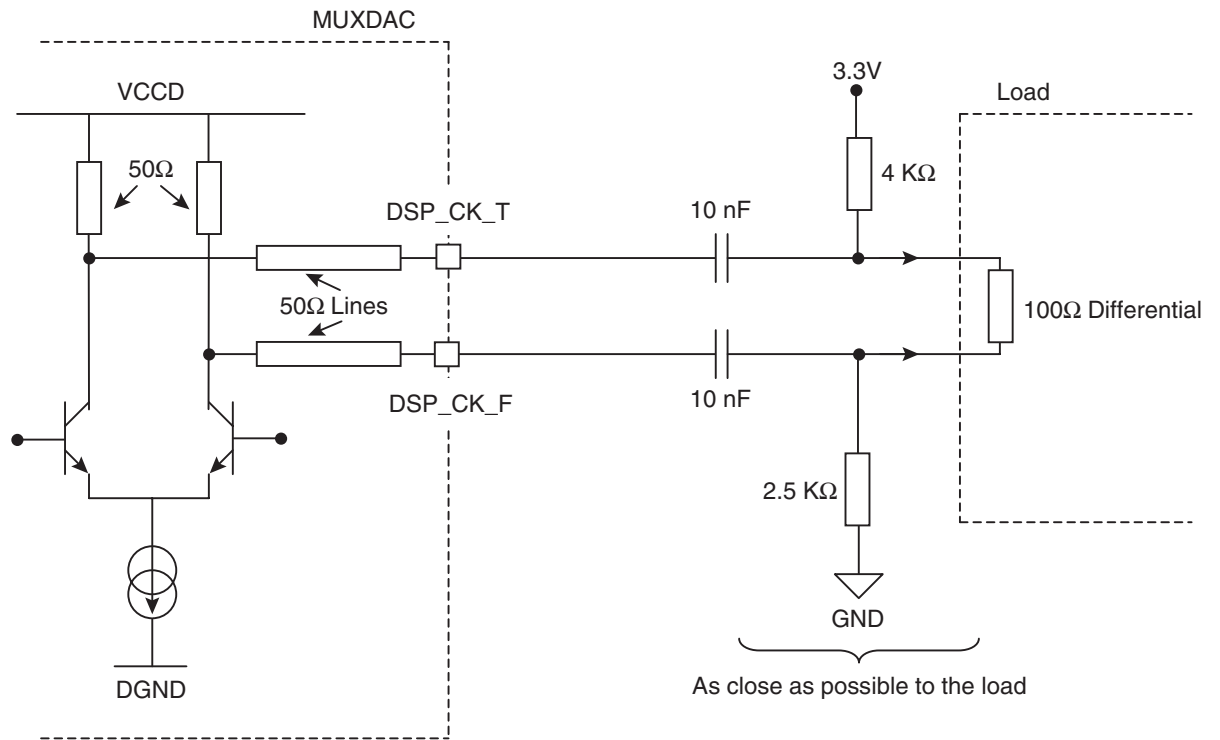
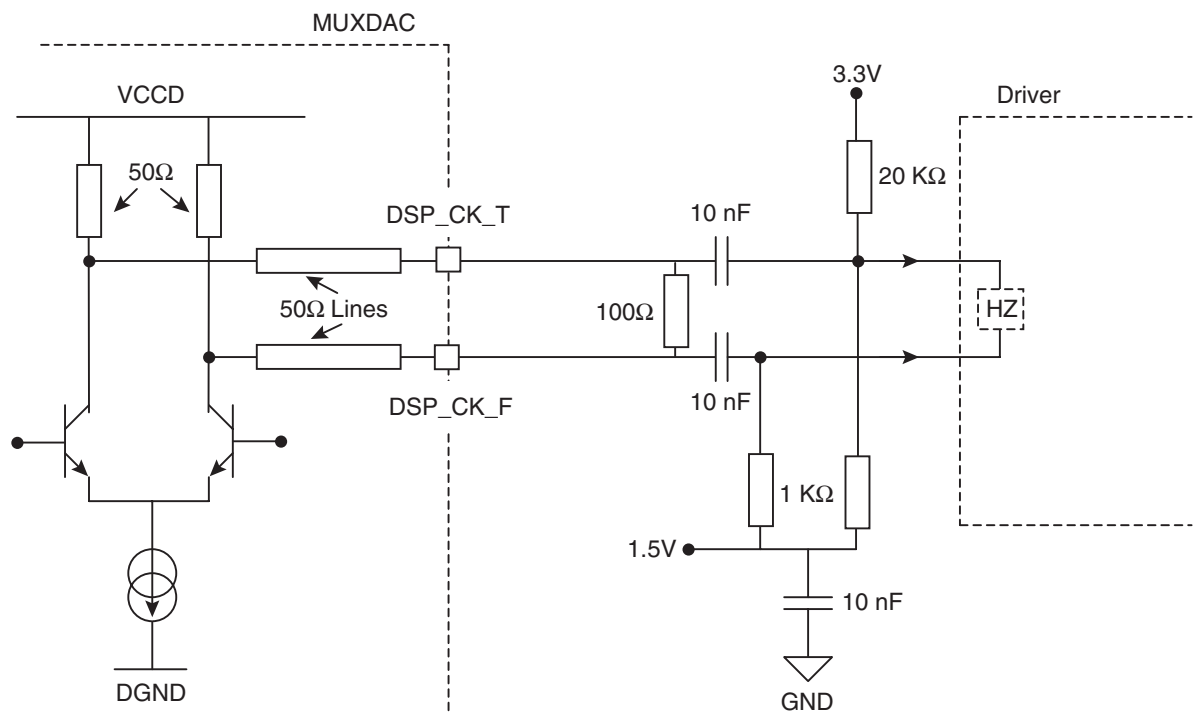


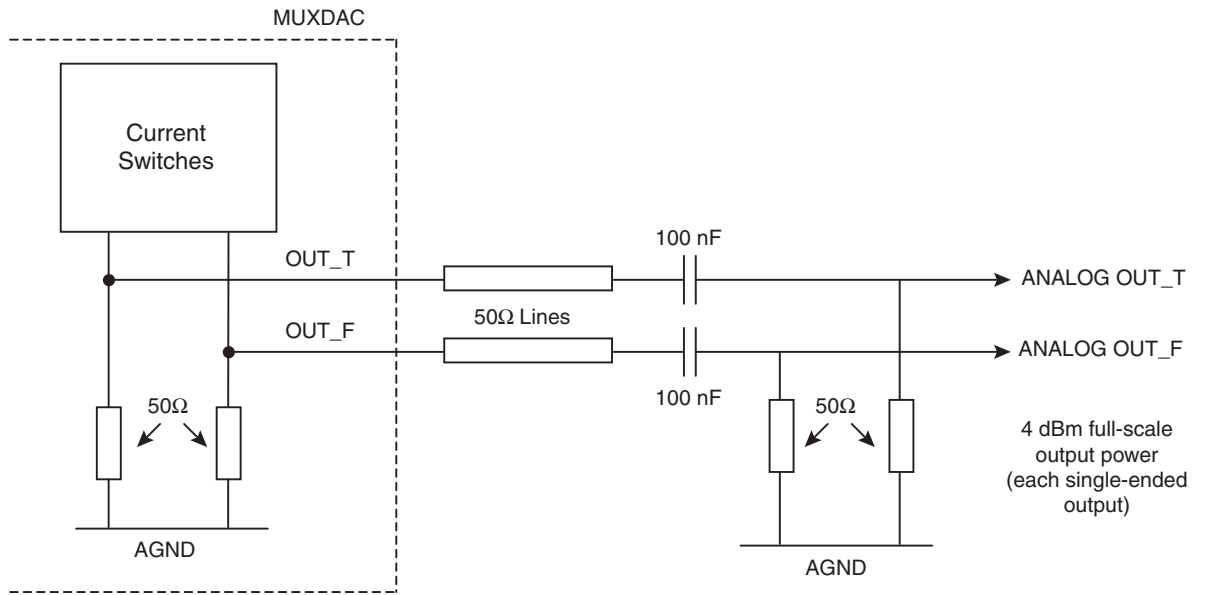
Figure 12-12. DSP Output Clock Implementation (General Case, Values Given for Information Only)



- Note:
1. For reference only, MC100EP17 (for a translation to PECL standard level on DSP\_CLK) or NBSG16 drivers from On Semiconductor® are well-suited to this application.
  2. The 100Ω differential resistor is not mandatory see note [Figure 12-10 on page 42](#).

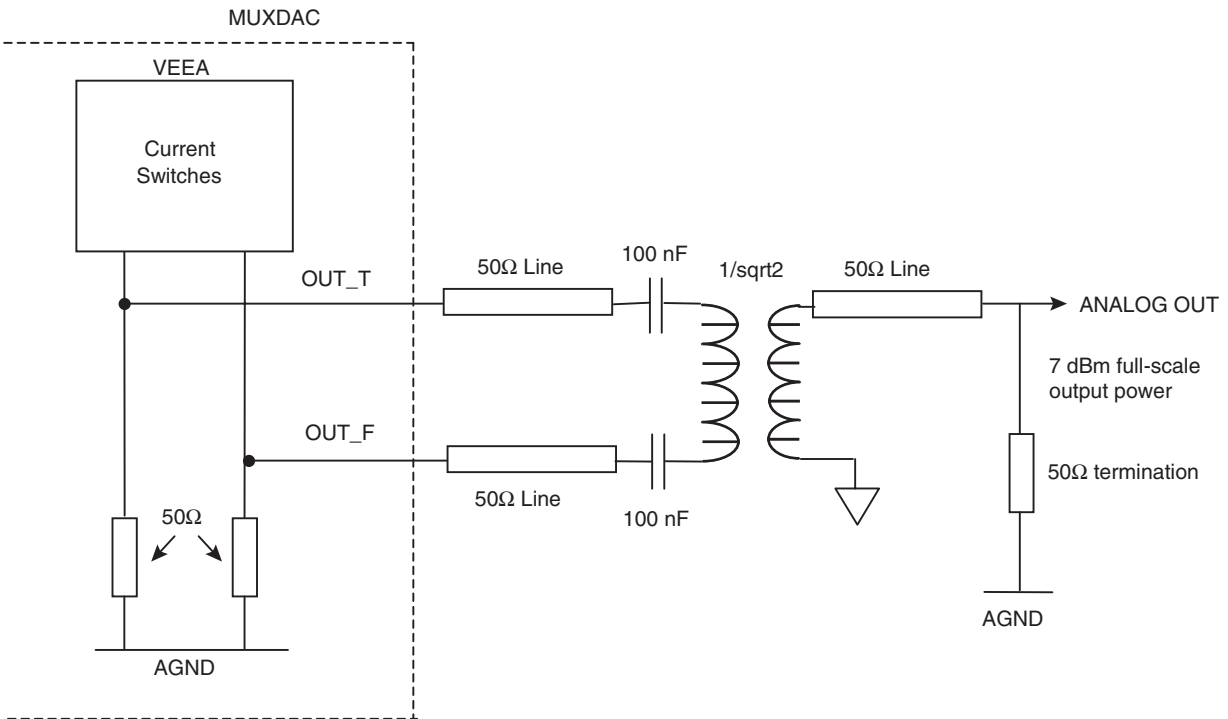
## 12.5 Analog Output Termination Scheme

Figure 12-13. Analog Output 2 × 50Ω Differential Termination Scheme



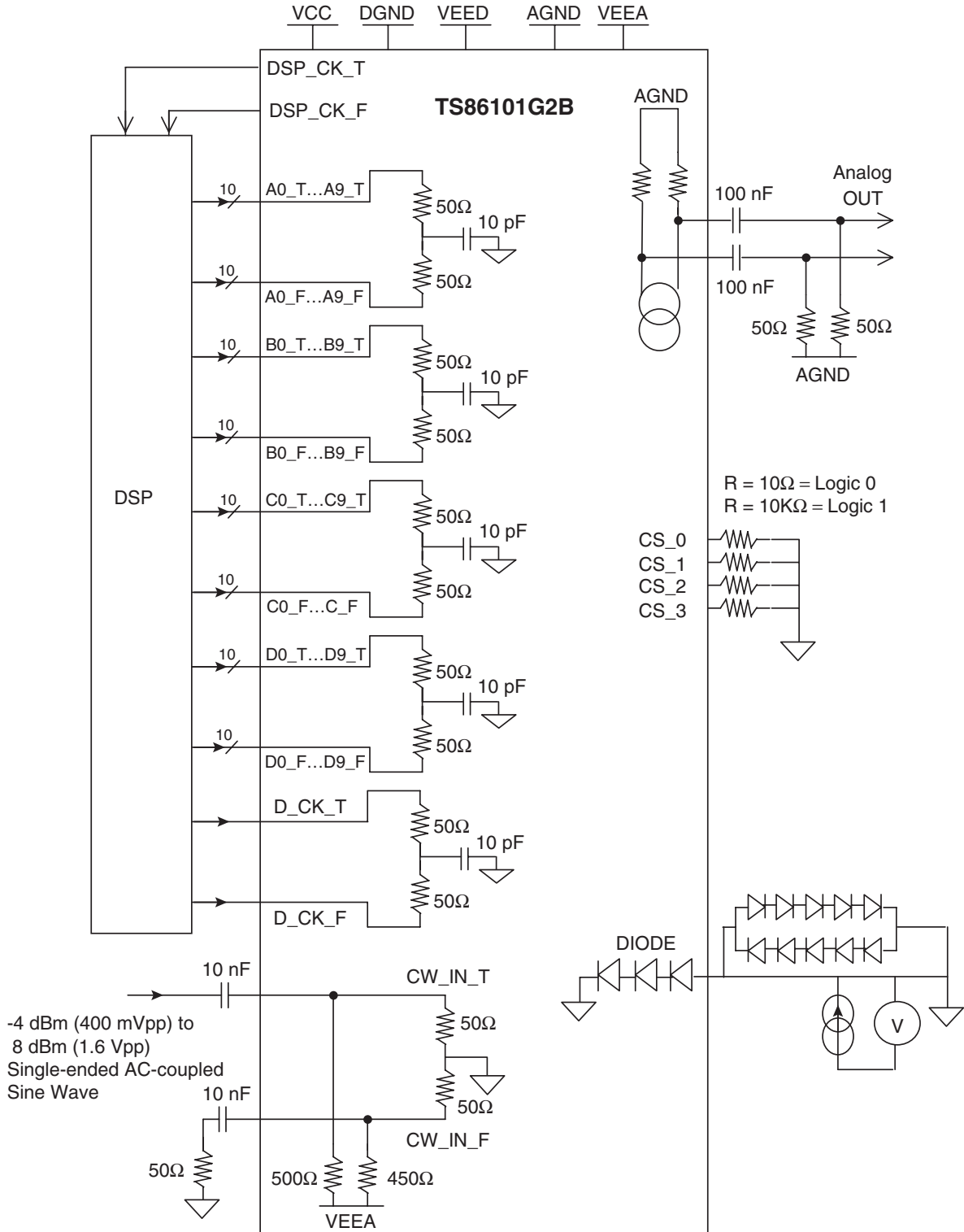
Note: The AC coupling capacitors are necessary to remove the DC component of the signals (−0.6V).

Figure 12-14. 50Ω Single-ended Output through a Differential to Single-ended  $1/\sqrt{2}$  Balun (1/√2 voltage ratio is necessary for correct 100Ω differential to 50Ω single-ended impedance transformation)



12.6 Interfacing the TS86101G2B MUXDAC with a Digital Signal Processor

Figure 12-15. Interfacing with a Digital Signal Processor



Note: All the data and clock inputs/outputs are connected via 50Ω impedance lines.

### 13. Mechanical Description of CBGA 255 Package

Figure 13-1. CBGA 255 Package Outline –Top View

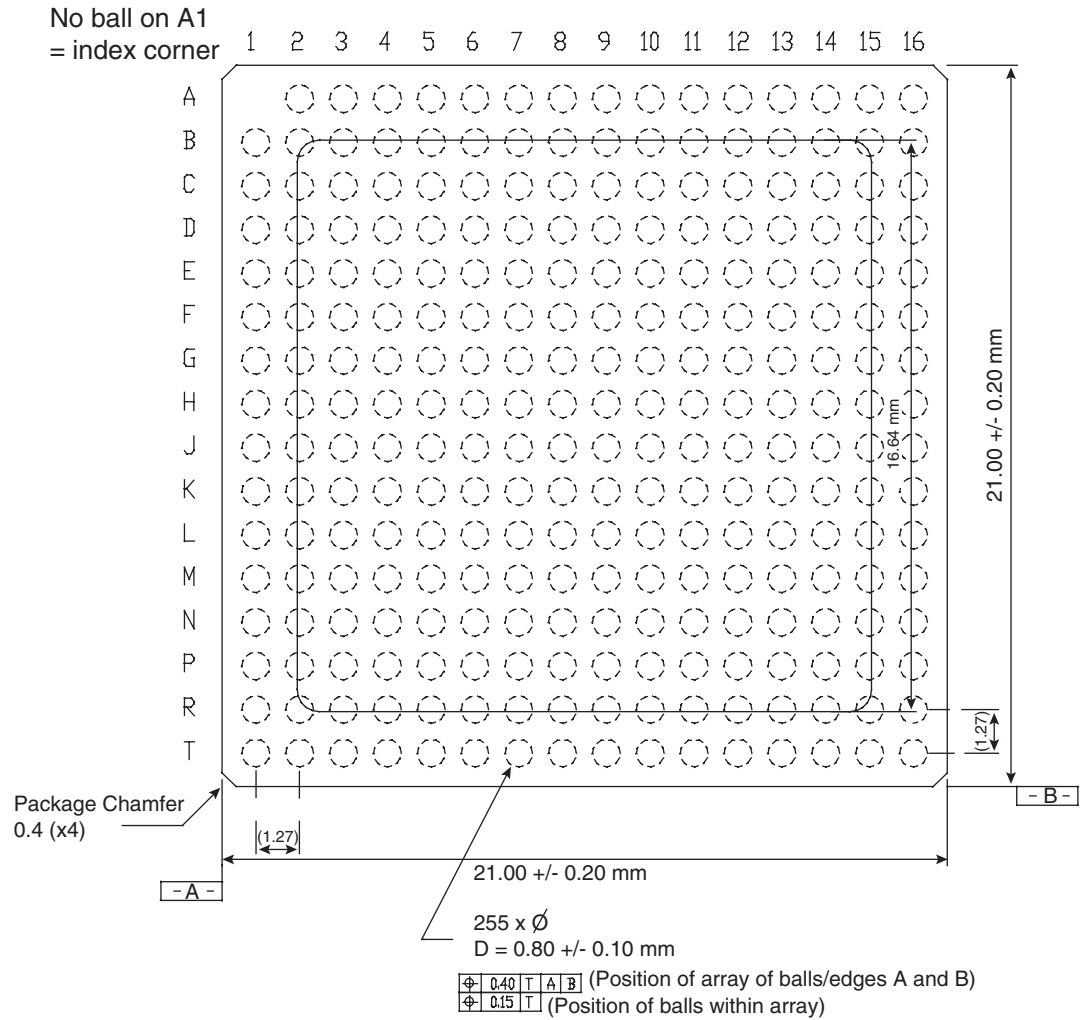
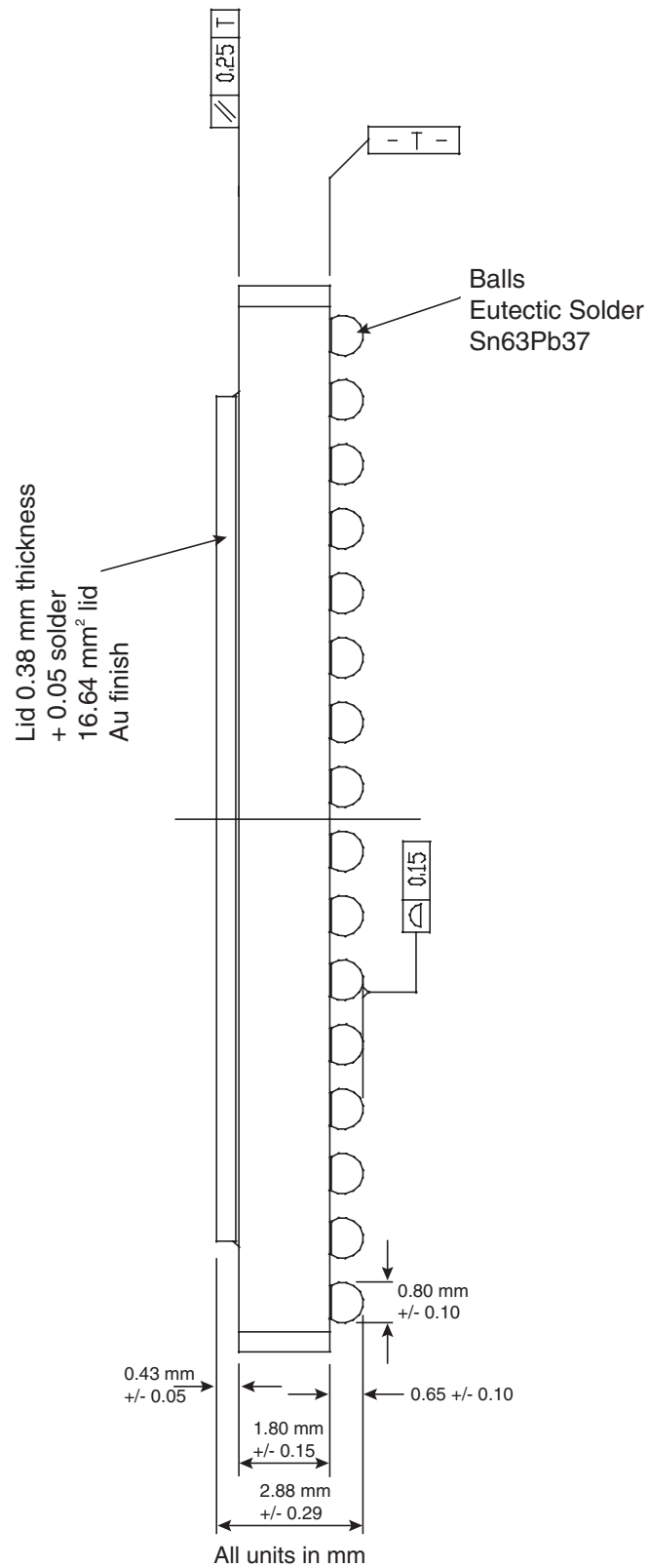


Figure 13-2. CBGA 255 Package Outline – Side View



For lead free roadmap, please contact your local e2v sales office.

Figure 13-3. CBGA 255 Package Outline – Cross Section

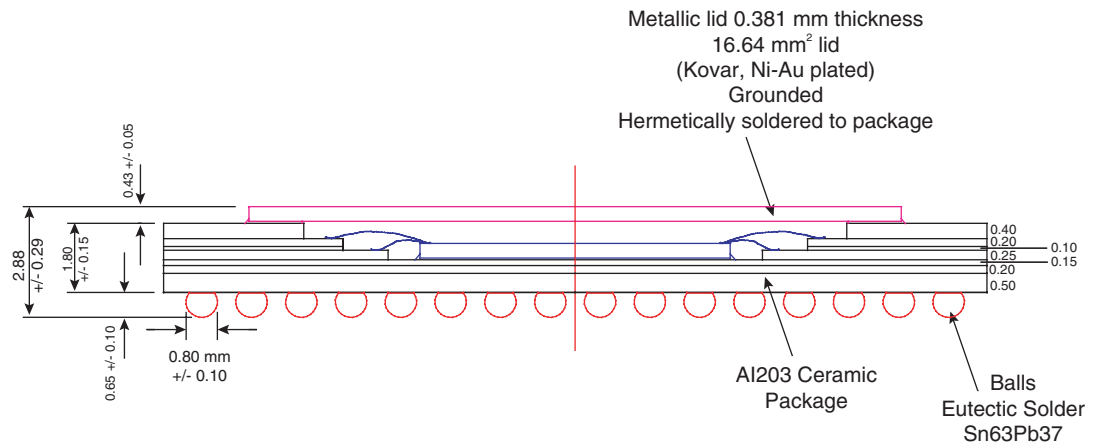
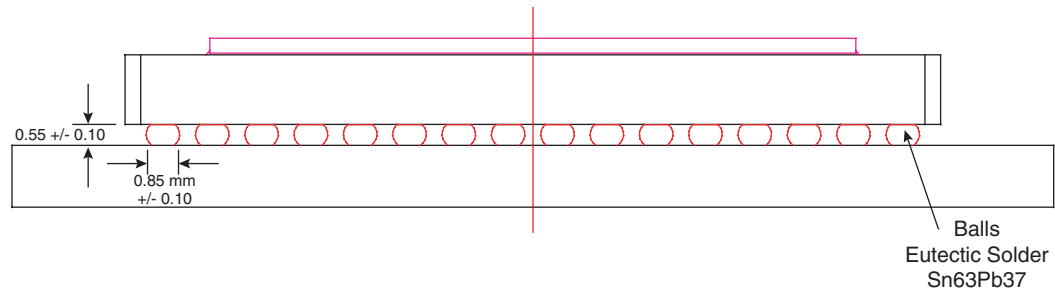


Figure 13-4. CBGA 255 Side View after Reflow



Note: After reflow, the height of the balls decreases from 0.65 to 0.55 mm because of the package weight. The diameter increases from 0.80 to 0.85 mm. This data is for information only and does not constitute part of e2v's specification.



# 14. Mechanical Description of CI-CGA 255 Package

Figure 14-1. CI-CGA 255 Package Outline - Top View

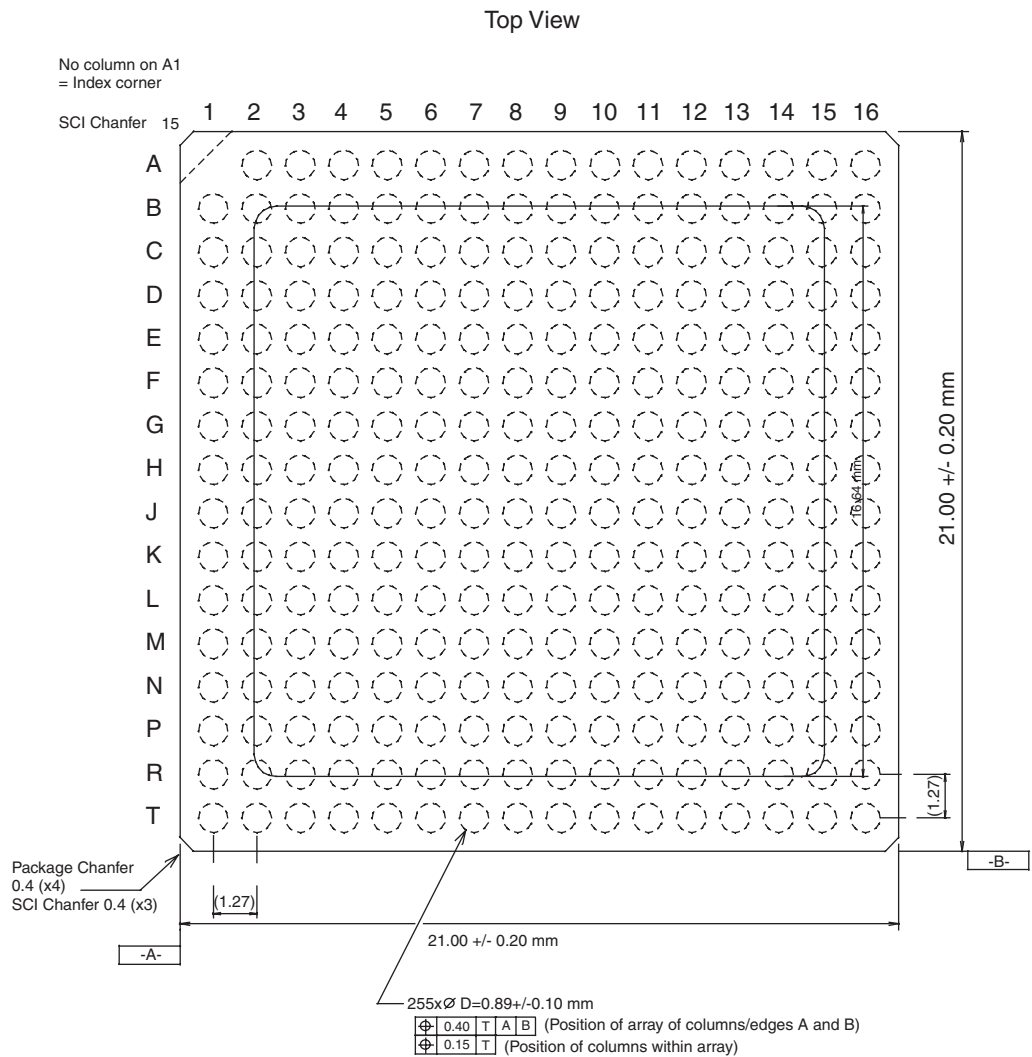
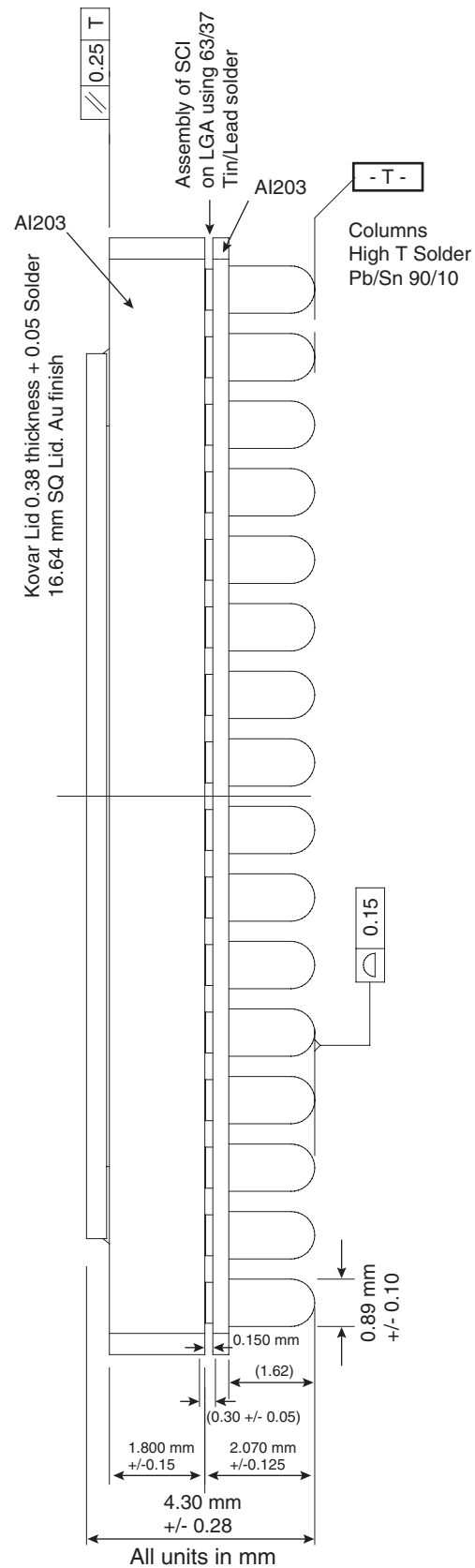
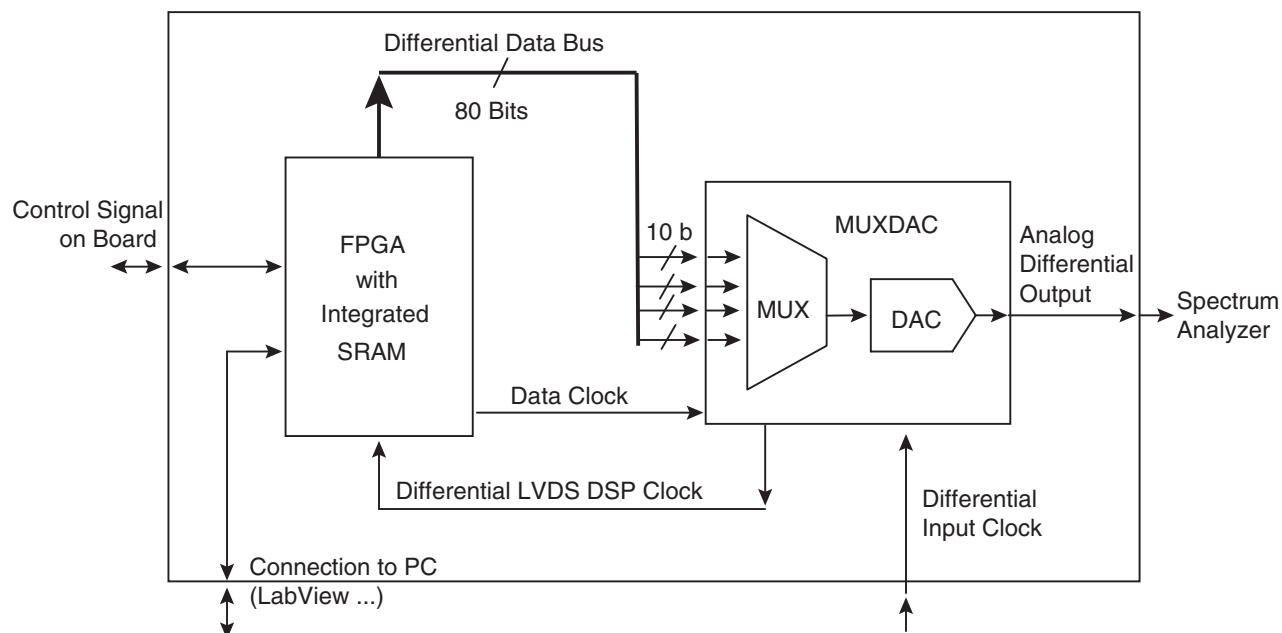


Figure 14-2. CI-CGA 255 Package Outline - Side View



## 15. TSEV86101G2BGL Evaluation Kit

Figure 15-1. TSEV86101G2BGL Evaluation Board



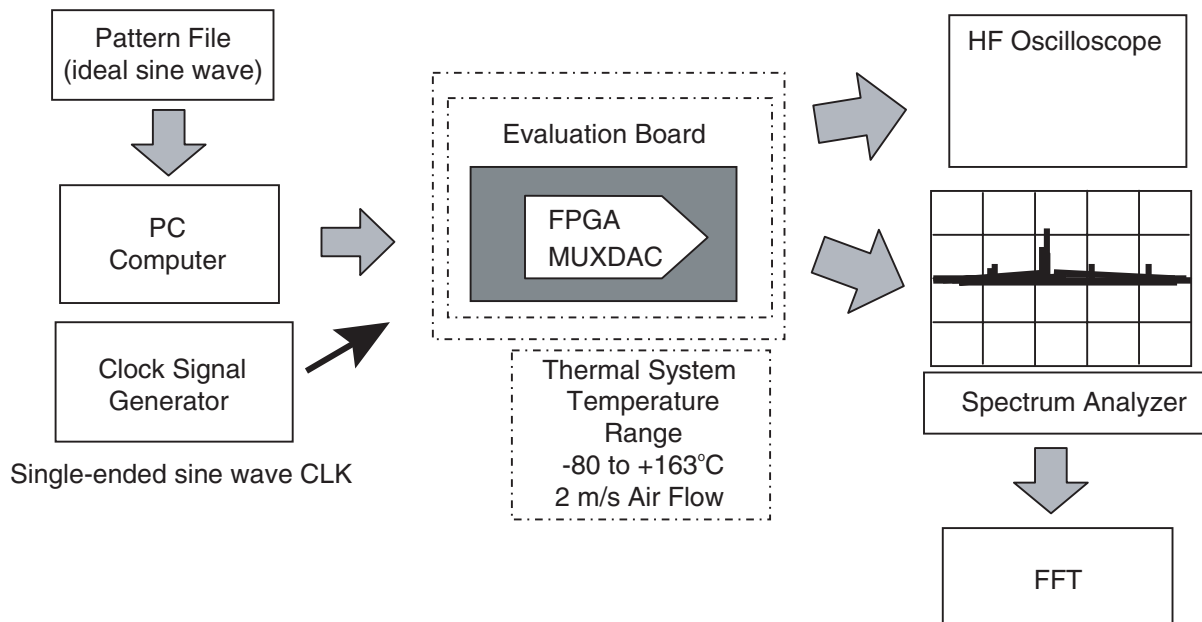
The TSEV86101G2BGL Evaluation Board is the main component of the Evaluation Kit needed to perform characterization of the TS86101G2B MUXDAC for sampling frequencies up to 600 Msps.

The evaluation system of the TS86101G2B MUXDAC device comprises a configurable printed circuit board (the evaluation board itself), including the soldered MUXDAC device (CBGA-255 package), an FPGA chip, a serial interface to a PC and a user interface.

The TSEV86101G2BGL evaluation kit contains all necessary software and hardware for setting up the board and performing its characterization.

## 16. Test Bench Description

Figure 16-1. Test Bench



The test bench, implemented to characterize the TS86101G2B MUXDAC using the evaluation kit (TSEV86101G2BGL), can be described as follows:

- A single-ended sine wave clock signal is sent to the board
- A pattern file loaded in a PC is sent to the FPGA via an RS-232 serial interface (the patterns correspond to ideal sinusoids using different frequencies)
- A thermal system above the evaluation board enables testing of the MUXDAC against temperature variations
- An oscilloscope helps define the time domain characteristics of the MUXDAC
- A spectrum analyzer helps locate/identify the MUXDAC's FFTs

## 17. Ordering Information

Part Number	Package	Temperature Range	Screening Level	Comments
TS86101G2BCGL	CBGA 255	C grade $0^{\circ}\text{C} < T_C; T_J < 90^{\circ}\text{C}$	Standard	
TS86101G2BVGL	CBGA 255	V grade $-40^{\circ}\text{C} < T_C; T_J < 110^{\circ}\text{C}$	Standard	
TS86101G2BMGS	CI-CGA 255	M grade $-55^{\circ}\text{C} < T_C; T_J < 125^{\circ}\text{C}$	Standard	
TSEV86101G2BGL	CBGA 255	Ambient	Prototype	Evaluation board

For lead free roadmap, please contact your local e2v sales office.

## 18. Appendix

### Datasheet Status

Status		Validity
Objective specification	This datasheet contains target and goal specifications for discussion with the client and application validation	Before design phase
Target specification	This datasheet contains target and goal specifications for product development	Valid during the design phase
Preliminary specification Alpha-site	This datasheet contains preliminary data. Additional data may be published on a later date and could include simulation results	Valid before the characterization phase
Preliminary specification Beta-site	This datasheet also contains characterization results	Valid before the industrialization phase
Product specification	This datasheet contains final product specifications	Valid for production purposes
<b>Limiting Values</b>		
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability		
<b>Application Information</b>		
Where application information is given, it is advisory and does not form part of the specification		

### 18.1 Life Support Applications

These products are not designed for use in life support appliances, devices or systems where malfunction of these products can reasonably be expected to result in personal injury. e2v customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify e2v for any damages resulting from improper use or sale.

## Table of Contents

	<b><i>Main Features</i></b> .....	<b>1</b>
	<b><i>Performance</i></b> .....	<b>1</b>
	<b><i>Applications</i></b> .....	<b>2</b>
	<b><i>Screening</i></b> .....	<b>2</b>
<b>1</b>	<b><i>Description</i></b> .....	<b>2</b>
<b>2</b>	<b><i>Specifications</i></b> .....	<b>2</b>
	2.1 Electrical Operating Characteristics .....	4
	2.2 Timing Characteristics .....	8
	2.3 Explanation of Test Levels .....	9
<b>3</b>	<b><i>Typical Characteristics</i></b> .....	<b>9</b>
<b>4</b>	<b><i>Pin Description</i></b> .....	<b>17</b>
<b>5</b>	<b><i>Functional Description</i></b> .....	<b>20</b>
	5.1 Device Overview .....	20
	5.2 Registering the Input Data .....	21
	5.3 Phase Relationship Between Data Ready and CW_IN Clock Input .....	22
<b>6</b>	<b><i>Main Features of the TS86101G2B</i></b> .....	<b>23</b>
	6.1 Input MUX .....	23
	6.2 Power-up Asynchronous Reset/Synchronization of Several TS86101G2B Devices .....	24
	6.3 Programmable DSP Clock .....	25
	6.4 Diode Pin for Die Junction Temperature Monitoring Function .....	26
	6.5 GA Pin .....	27
<b>7</b>	<b><i>Block Diagram</i></b> .....	<b>28</b>
<b>8</b>	<b><i>Timing Diagram</i></b> .....	<b>29</b>
<b>9</b>	<b><i>Equivalent Input/Output Schematics</i></b> .....	<b>31</b>
<b>10</b>	<b><i>Definitions of Terms</i></b> .....	<b>35</b>
<b>11</b>	<b><i>Thermal and Moisture Characteristics</i></b> .....	<b>36</b>
<b>12</b>	<b><i>Applying the TS86101G2B MUXDAC</i></b> .....	<b>37</b>
	12.1 Accessing Power Supplies .....	37
	12.2 Digital Inputs and Data Ready Signal Implementation .....	39

12.3	CW_IN Master Clock Implementation .....	41
12.4	DSP Output Clock Implementation .....	41
12.5	Analog Output Termination Scheme .....	44
12.6	Interfacing the TS86101G2B MUXDAC with a Digital Signal Processor .....	45
<b>13</b>	<b><i>Mechanical Description of CBGA 255 Package .....</i></b>	<b>46</b>
<b>14</b>	<b><i>Mechanical Description of CI-CGA 255 Package .....</i></b>	<b>49</b>
<b>15</b>	<b><i>TSEV86101G2BGL Evaluation Kit .....</i></b>	<b>51</b>
<b>16</b>	<b><i>Test Bench Description .....</i></b>	<b>52</b>
<b>17</b>	<b><i>Ordering Information .....</i></b>	<b>52</b>
<b>18</b>	<b><i>Appendix .....</i></b>	<b>53</b>
18.1	Life Support Applications .....	53



## How to reach us

Home page: [www.e2v.com](http://www.e2v.com)

### Sales offices:

#### Europe Regional sales office

##### e2v ltd

106 Waterhouse Lane  
Chelmsford Essex CM1 2QU  
England  
Tel: +44 (0)1245 493493  
Fax: +44 (0)1245 492492  
mailto: [enquiries@e2v.com](mailto:enquiries@e2v.com)

##### e2v sas

16 Burospace  
F-91572 Bièvres Cedex  
France  
Tel: +33 (0) 16019 5500  
Fax: +33 (0) 16019 5529  
mailto: [enquiries-fr@e2v.com](mailto:enquiries-fr@e2v.com)

##### e2v gmbh

Industriestraße 29  
82194 Gröbenzell  
Germany  
Tel: +49 (0) 8142 41057-0  
Fax: +49 (0) 8142 284547  
mailto: [enquiries-de@e2v.com](mailto:enquiries-de@e2v.com)

#### Americas

##### e2v inc

520 White Plains Road  
Suite 450 Tarrytown, NY 10591  
USA  
Tel: +1 (914) 592 6050 or 1-800-342-5338,  
Fax: +1 (914) 592-5148  
mailto: [enquiries-na@e2v.com](mailto:enquiries-na@e2v.com)

#### Asia Pacific

##### e2v ltd

11/F.,  
Onfem Tower,  
29 Wyndham Street,  
Central, Hong Kong  
Tel: +852 3679 364 8/9  
Fax: +852 3583 1084  
mailto: [enquiries-ap@e2v.com](mailto:enquiries-ap@e2v.com)

#### Product Contact:

e2v  
Avenue de Rochepleine  
BP 123 - 38521 Saint-Egrève Cedex  
France  
Tel: +33 (0)4 76 58 30 00  
**Hotline:**  
mailto: [hotline-bdc@e2v.com](mailto:hotline-bdc@e2v.com)

Whilst e2v has taken care to ensure the accuracy of the information contained herein it accepts no responsibility for the consequences of any use thereof and also reserves the right to change the specification of goods without notice. e2v accepts no liability beyond that set out in its standard conditions of sale in respect of infringement of third party patents arising from the use of tubes or other devices in accordance with information contained herein.



