PV5870

IQ Direct Conversion Modulator / Demodulator

The PV5870 is a direct conversion quadrature modulator / demodulator designed for communication systems requiring excellent linearity with the lowest power consumption in the industry. The device is optimized for wide-band applications with RF inputs ranging from 400 –3600MHz.

Benefits of the component include excellent amplitude and phase balance, low conversion loss with low noise figure, very low DC offset, and low power dissipation. Intermodulation products IM2 and IM3 can be optimized through adjustment. RF, LO and baseband interfaces are fully differential. The baseband outputs of the device can interface directly to baseband amplifiers or low-pass filters.

The excellent linearity of the PV5870 direct conversion quadrature demodulator can improve receiver dynamic range and significantly reduce bill of materials cost by eliminating the need for IF signal processing components.

Performance as a modulator is equally impressive. Excellent sideband suppression of >40dBc and carrier leakage of <-40dBm are achievable without adjustment for 900MHz applications. The on-channel LO input has a broad operating range from -6dBm to +6dBm. The modulator core operates from a 1.8V power supply while providing an OIP3 of +21dBm and OIP2 of +60dBm along with a P1dB of +7.5dBm at 900MHz. The LO path uses a +3V power supply that can be regulated as low as 2.85V.

General Features

- **Very Low Power Consumption: <130mW**
- Operating RF Frequency:
  - 400 MHz to 3600 MHz
- Small PCB Area and Layout
- 20-Lead QFN Package

IQ Demodulator

- Highest Linearity in Class:
  - IIP3 +30dBm, IIP2 +70dBm adjustable
- Low Insertion Loss: 2.2dB @ 900MHz
- Noise Figure: 3.1dB @ 900MHz
- Phase Accuracy: 1° typical
- Amplitude Imbalance: 0.05dB typical

IQ Modulator

- CDMA ACPR -64dBc / -88dBc
- Carrier Leakage: - 42dBm @ 900MHz
- Sideband Suppression: 40dBc typical
- 1dB Output Compression: +7.5dBm @ 900MHz
- OIP3 +21dBm, OIP2 +60dBm @ 900MHz
- Output Return Loss: 12dB

Applications

- LTE, W-CDMA Base Station Receivers/Transmitters
- Digital Pre-Distortion
- RF-Identification (RFID)
- Wireless Local Loop (WLL)
- High-Linearity Direct Conversion
- Point-to-Point Broadband Radio

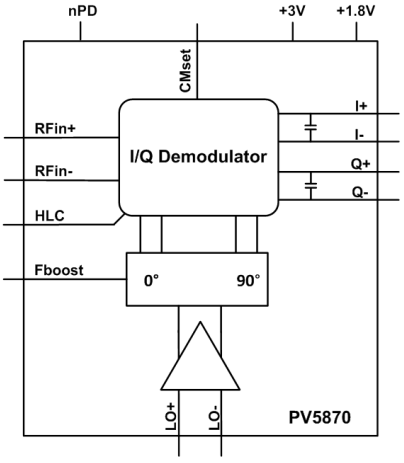


Figure 1: PV5870 (as demodulator)

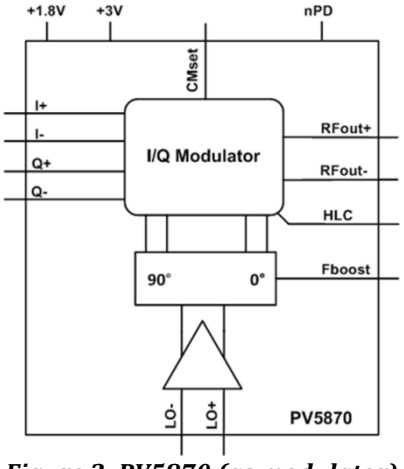


Figure 2: PV5870 (as modulator)

Contents

Pin Description

Pin Number	Pin Name	Description	ESD
1	GND	GND	Ground
2	CMset	Common mode for IM adjustment	yes
3	GND	GND	Ground
4	HLC	Logic 1 (tie pin to VDD3p0 typically) or apply Logic “0” to increase P1dB[1]	yes
5	Fboost	Logic “0” for LO frequencies ≤ 2600MHz Logic “1” for LO frequencies > 2600MHz	yes
6	VDD3p0	+3V analog power supply	yes
7	LO+	Local oscillator positive input	no
8	GND	Ground	
9	LO-	Local oscillator negative input	no
10	VDD1p8	+1.8V digital power supply	yes
11	nPD	Power down / sleep mode logic control	yes
12	I+	I channel baseband positive output	yes
13	I-	I channel baseband negative output	yes
14	Q+	Q channel baseband positive output	yes
15	Q-	Q channel baseband negative output	yes
16	GND	Ground	
17	RFin+	RF positive input	no
18	PW	Ground (can be biased from 0Vdc to +1.5Vdc)	
19	RFin-	RF negative input	no
20	GND	Ground	
21[2]	epad	Ground	

Notes:

1. Logic “0” on HLC pin 4 can be used to increase input referred P1dB to +21dBm. This is normally considered a temporary operating condition and will increase conversion loss. It can also be used to increase the frequency range to 4GHz.
2. Exposed pad on bottom of package

Absolute Minimum and Maximum Ratings

Parameter	Symbol	Conditions	Min	Max	Unit
PV5870 Supply Voltage(s)					
+3V Supply	V_{DD3p0}		-0.3	+3.6	Vdc
+1.8V Supply	V_{DD1p8}		-0.3	+1.98	Vdc
Storage Temp			-40	+140	° C
Clock (LO) Input Power	CLKp, CLKn	AC coupled		+10	dBm
RF Input Power	RFp, RFn	AC coupled		TBD	dBm
Enable Voltage	nPD		-0.3	V_{DD3p0}+0.3	V
BB Inputs	I+,I-, Q+, Q-	Each input	-0.3	1.5	Vp-p
IM Adjustment	CMset		-0.3	2.5	V

DC Specifications

(TA = +25 ° C, VDD3p0 = +3V, VDD1p8 = +1.8V, VCM_{BB}=1.5V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Temperature Range			-40		+85	°C
Power Supply						
Supply Voltage	V_{DD3p0}		2.85	3.0	3.3	V
Supply Current	I_{DD3p0}	LO tuned to 900MHz		23		mA
		LO tuned to 2.45GHz		23		mA
Supply Voltage	V_{DD1p8}		1.71	1.8	1.98	V
Supply Current	I_{DD1p8}	LO tuned to 900MHz		33		mA
		LO tuned to 2.45GHz		72		mA
Power Down Current				10		uA
Enable Voltage	nPD	PD5870 “on”	2.25			V
		PV5870 “off”			0.5	V
CMset Adjustment Range	CMset		1.5		2.2	V

RF Input Specifications

(TA = +25 ° C, VDD3p0 = +3V, VDD1p8 = +1.8V, VCM_{BB}=1.5V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
RF Input Frequency	RF_{Freq}	Fboost=0, HLC=1	400		2600	MHz
		Fboost=1, HLC=1	2300		3600[3]	MHz
Clock (LO) Input Frequency	LO_{Freq}	Fboost=0, HLC=1	400		2600	MHz
		Fboost=1, HLC=1	2300		3600[3]	MHz
Clock (LO) Input Power	P_{LO}	LO_{Freq} = 400MHz to 3000MHz	-6	-3	0	dBm
		LO_{Freq} = 3000MHz to 3600MHz	0	+3	+6	dBm
RF I-Q Demodulator: fLO = 900MHz, fRF1 = 901MHz, fRF2 = 901.8MHz, Fboost=0, HLC=1 [4]						
Quadrature phase error		F_{RFIN}=901MHz, F_{LO}=900MHz	-2		+2	°
I/Q Amplitude Imbalance		F_{RFIN}=901MHz, F_{LO}=900MHz	-0.5		0.5	dB
Third-Order Intercept	IIP3	P_{IN1}, P_{IN2} = -10dBm each tone.	+25	+30		dBm
Second-Order Intercept	IIP2	P_{IN1}, P_{IN2} = -10dBm each tone.		+70[5]		dBm
Input Compression	IP1dB	Fboost=0, HLC=1		+14		dBm
		Fboost=1, HLC=1		+14		dBm
		Fboost=1, HLC=0		+21		dBm
LO Leakage		F_{LO}=F_{RF}, RFIN Differential		-60		dBm
Conversion Loss[6]		Fboost=0, HLC=1, P_{LO}=0dBm		2.2		dB
		Fboost=1, HLC=1, P_{LO}=0dBm		2.6		dB
		Fboost=1, HLC=0, P_{LO}=0dBm		9.6		dB
DSB Noise Figure[6]	NF	Fboost=0, HLC=1, P_{LO}=0dBm		3.1		dB
		Fboost=1, HLC=1, P_{LO}=0dBm		3.6		dB
		Fboost=1, HLC=0, P_{LO}=0dBm		9.8		dB
Baseband Bandwidth	BW_{3dB}	I or Q, Differential baseband load 125 Ohms			300[7]	MHz
RF I-Q Demodulator: fLO = 2450MHz, fRF1 = 2451MHz, fRF2 = 2451.8MHz, Fboost=0, HLC=1 [4]						
Quadrature phase error		F_{RFIN}=2451MHz, F_{LO}=2450MHz	-2		+2	°
I/Q Amplitude Imbalance		F_{RFIN}=2451MHz, F_{LO}=2450MHz	-0.5		0.5	dB
Third-Order Intercept	IIP3	P_{IN1}, P_{IN2} = -10dBm each tone.	+25	+28		dBm
Second-Order Intercept	IIP2	P_{IN1}, P_{IN2} = -10dBm each tone.		+65[5]		dBm
Input Compression	IP1dB	Fboost=0, HLC=1		+14		dBm
		Fboost=1, HLC=1		+14		dBm
		Fboost=1, HLC=0		+20		dBm

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
LO Leakage		$F_{LO}=F_{RF}$, RFIN Differential		-42		dBm
Conversion Loss[6]		Fboost=0, HLC=1, P_{LO}=0dBm Fboost=1, HLC=1, P_{LO}=0dBm Fboost=1, HLC=0, P_{LO}=0dBm		3.3 3.3 8.5		dB dB dB
DSB Noise Figure[6]	NF	Fboost=0, HLC=1, P_{LO}=0dBm Fboost=1, HLC=1, P_{LO}=0dBm Fboost=1, HLC=0, P_{LO}=0dBm		7.0 4.8 9.5		dB dB dB
Baseband Bandwidth	BW_{3dB}	I or Q, Differential baseband load 125 Ohms			300[7]	MHz
RF I-Q Demodulator: fLO = 3000MHz, fRF1 = 3001MHz, fRF2 = 3001.8MHz, Fboost=1, HLC=1 [4]						
Quadrature phase error		F_{RFIN}=3001MHz, F_{LO}=3000MHz	-2		+2	°
I/Q Amplitude Imbalance		F_{RFIN}=3001MHz, F_{LO}=3000MHz	-0.5		0.5	dB
Third-Order Intercept	IIP3	P_{IN1}, P_{IN2} = -10dBm each tone.		+25		dBm
Second-Order Intercept	IIP2	P_{IN1}, P_{IN2} = -10dBm each tone.		+65		dBm
Input Compression	IP1dB	Fboost=1, HLC=1 Fboost=1, HLC=0		+12 TBD		dBm dBm
LO Leakage		$F_{LO}=F_{RF}$, RFIN Differential		-50		dBm
Conversion Loss[6]		Fboost=1, HLC=1 Fboost=1, HLC=0		3.3 6.5		dB dB
DSB Noise Figure[6]	NF	Fboost=1, HLC=1 Fboost=1, HLC=0		6.3 8.9		dB dB
Baseband Bandwidth	BW_{3dB}	I or Q, Differential baseband load 125 Ohms			300[7]	MHz
RF I-Q Demodulator: fLO = 3600MHz, fRF1 = 3601MHz, fRF2 = 3601.8MHz, Fboost=1, HLC=1 [4]						
Quadrature phase error		F_{RFIN}=3601MHz, F_{LO}=3600MHz	-2		+2	°
I/Q Amplitude Imbalance		F_{RFIN}=3601MHz, F_{LO}=3600MHz	-0.5		0.5	dB
Third-Order Intercept	IIP3	P_{IN1}, P_{IN2} = -10dBm each tone.		+22		dBm
Second-Order Intercept	IIP2	P_{IN1}, P_{IN2} = -10dBm each tone.		+47		dBm
Input Compression	IP1dB	Fboost=1, HLC=1 Fboost=1, HLC=0		+11 TBD		dBm dBm
LO Leakage		$F_{LO}=F_{RF}$, RFIN Differential		-37		dBm
Conversion Loss[6]		Fboost=1, HLC=1,P_{LO}=+3dBm Fboost=1, HLC=1, P_{LO}=+6dBm Fboost=1, HLC=0, P_{LO}=0dBm		5 5 6.6		dB dB dB
DSB Noise Figure[6]	NF	Fboost=1, HLC=1, P_{LO}=+3dBm Fboost=1, HLC=1, P_{LO}=+6dBm Fboost=1, HLC=0, P_{LO}=0dBm		14.8 12.6 9		dB dB dB
Baseband Bandwidth	BW_{3dB}	I or Q, Differential baseband load 125 Ohms			300[7]	MHz

Notes:

3. Higher LO power ≥0dBm is required for operation to 3600MHz
4. Mini-Circuits TC1-1-13 baluns on RF and LO ports, Coilcraft WB2.5-6TSL transformer on baseband ports
5. CMset = +2V to +2.1V, Fboost=0, HLC=1
6. Transformer and evaluation board losses de-embedded
7. Will be limited by choice of load and/or transformer

RF Output Specifications

(TA = +25 ° C, VDD3p0 = +3V, VDD1p8 = +1.8V, VCM_{BB}=1.5V)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
RF I-Q Modulator: fLO = 900MHz, F1=+3.5MHz F2=+4.5MHz [8,9]						
Output Power		V_I=V_Q=2Vp-p differential		+5		dBm
Output IP3	OIIP3	P_{OUT} = -8dBm each tone		+21		dBm
Output IP2	OIIP2	P_{OUT} = -8dBm each tone		+60		dBm
Output P1dB	OP1dB	CMset(pin 2) =1.8Vdc		+7.5		dBm
Carrier Feedthrough		No adjustment		-42		dBm
Sideband Suppression		No adjustment		40		dBc
Quadrature phase error			-2		+2	°
I/Q Amplitude Imbalance			-0.5		0.5	dB
Noise Floor		LO input power 0dBm		-148		dBm/Hz
Baseband Bandwidth	BW_{3dB}			200[10]		MHz
RF Return Loss		Balun dependent		12		dB
LO Input Return Loss		Balun dependent		12		dB
RF I-Q Modulator: fLO = 2450MHz, F1=+3.5MHz F2=+4.5MHz [8,9]						
Output Power		V_I=V_Q=2Vp-p differential		+4		dBm
Output IP3	OIIP3	P_{OUT} = -8dBm each tone, CMset=1.8Vdc		+17		dBm
Output IP2	OIIP2	P_{OUT} = -8dBm each tone, CMset=1.8Vdc		+50		dBm
Output P1dB	OP1dB	CMset(pin 2) =1.8Vdc		+6		dBm
Carrier Feedthrough		No adjustment		-42		dBm
Sideband Suppression		No adjustment		-35		dBc
Quadrature phase error			-2		+2	°
I/Q Amplitude Imbalance			-0.5		0.5	dB
Noise Floor		LO input power 0dBm		-145		dBm/Hz
Baseband Bandwidth	BW_{3dB}			200[10]		MHz
RF Return Loss		Balun dependent		12		dB
LO Input Return Loss		Balun dependent		12		dB
Cellular Modulation: CDMA2000, fLO = 837MHz, LO power = -3dBm, CMset = 2Vdc						
ACPR (CDMA2K Modulation)		885KHz (Pout=-2dBm) 1.98MHz		64 88		dBc dBc

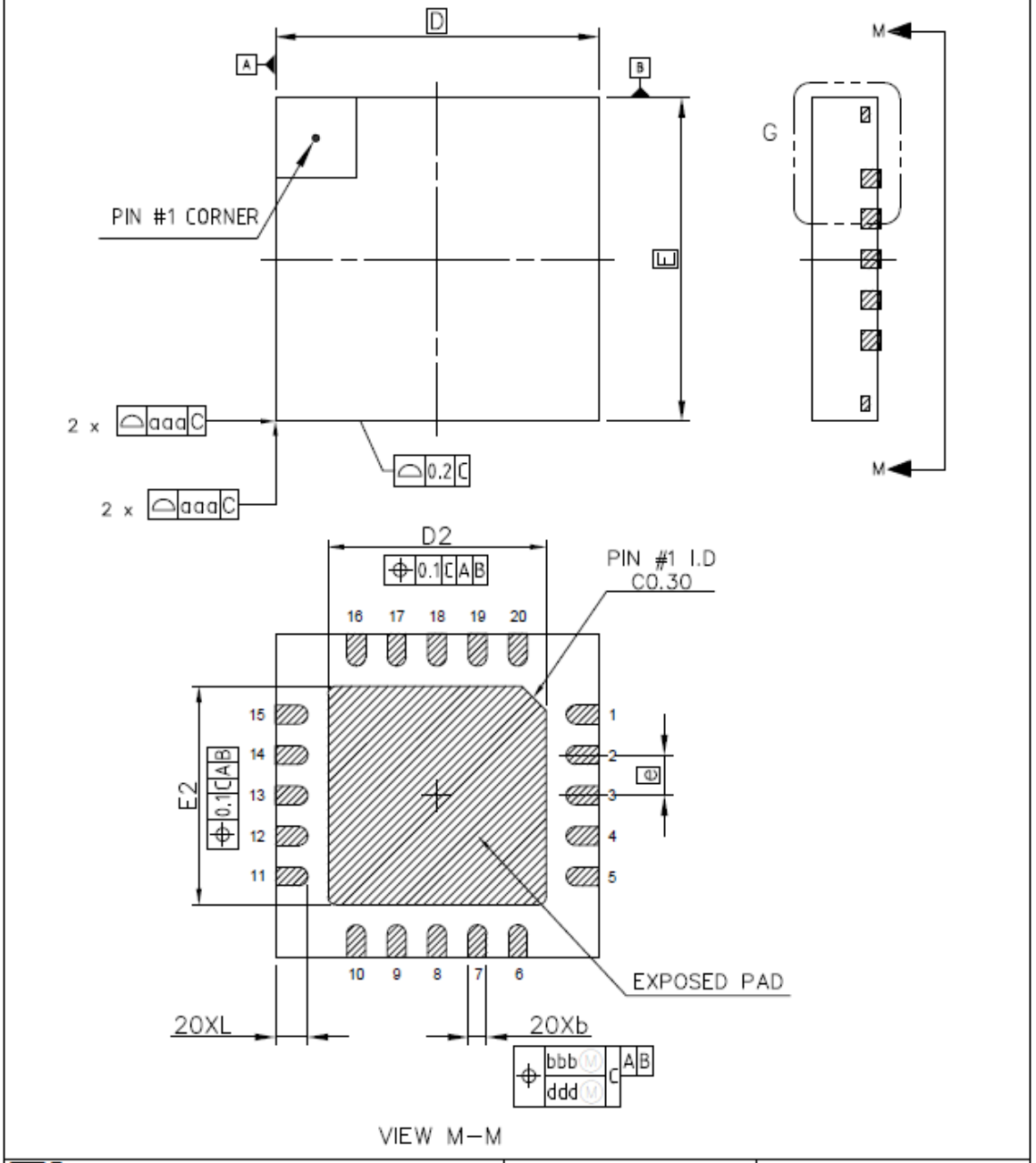
Notes:

8. Mini-Circuits TC1-1-13 baluns on RF and LO ports
9. CMset at +1.8V
10. Choice of operational amplifier, transformer, and source impedance will influence the realizable baseband bandwidth.

Package Description

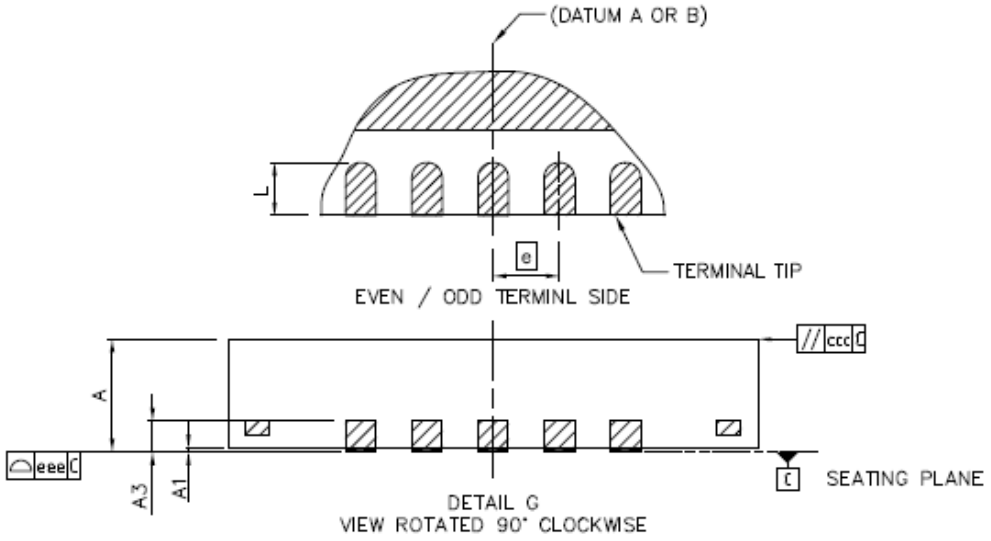
20-Lead Plastic QRN (4mm x 4mm)

ASE Advanced Semiconductor Engineering Korea, Inc.	PACKAGE OUTLINE	DWG NO.	98SPP20051A
		ISSUE	O
		DATE	NOV.10,2009



TITLE: QFN 4X4 20LD 2.90X2.90mm PAD / Full lead type		COMPANY	*ASE KOREA*
		SHEET	1 OF 3

ASE Advanced Semiconductor Engineering Korea, Inc.	PACKAGE OUTLINE	DWG NO.	98SPP20051A
		ISSUE	O
		DATE	NOV.10,2009



DIM	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	0.00		0.05
A3		0.203 REF	
b	0.18	0.23	0.28
D		4.00 BSC	
E		4.00 BSC	
D2	2.60	2.70	2.80
E2	2.60	2.70	2.80
e		0.50 BSC	
L	0.35	0.40	0.45
aaa		0.10	
bbb		0.10	
ccc		0.10	
ddd		0.05	
eee		0.08	

NOTES

1.0 DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994.

2.0 ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.

3.0 DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25mm AND 0.30mm FROM TERMINAL TIP. DIMENSION L1 REPRESENTS TERMINAL FULL BACK FROM PACKAGE EDGE UP TO 0.1mm IS ACCEPTABLE.

4.0 COPLANARITY APPLIES TO THE EXPOSED HEAT SLUG AS WELL AS THE TERMINAL.

5.0 RADIUS ON TERMINAL IS OPTIONAL.

UNIT	DIMENSION AND TOLERANCE	REFERENCE DOCUMENT
Millimeter(mm)	ASME Y14.5M	JEDEC MO-220

TITLE:	COMPANY	*ASE KOREA*
QFN 4X4 20LD 2.90X2.90mm PAD / Full lead type	SHEET	2 OF 3