Neptune

CDMA/AMPS/TDMA Filter for Digital Phones

Preliminary Information

Supersedes June 1997 version, DS4723 - 2.1

DS4723 - 3.2 February 1998

NEPTUNE is a monolithic active low pass filter circuit incorporating circuits for receiving both CDMA and AMPS/ TDMA signals. In CDMA mode operation, a lowpass filtering function will provide a minimum of 34dB ± 10dB voltage gain inband and >50dB stopband attenuation. Each of the CDMA balanced I/Q channels has a 7th order elliptic continuous time filter (preset by external resistor) tunable over the range. In FM mode the AMPS/TDMA channel provides 47dB+/-10dB voltage gain, but uses an external bandpass ceramic filter (see circuit block diagram). In both CDMA and FM (AMPS/ TDMA) modes, the amplifiers' gain values are controllable. The circuit is supplied in a 28 pin SSOP package.

FEATURES

CDMA Path

- I/Q tunable channel filters for CDMA
- Low inband gain ripple (<0.7dB, 2kHz to 535kHz)
- Filters designed to compensate for CDMA system's inband phase distortion
- Low cutoff-frequency variation with temperature and supply (< ± 2.5%)
- 34dB nominal voltage gain
- ±10dB independent I/Q gain adjust range
- Low gain variation over temperature and supply (< ± 0.5dB)

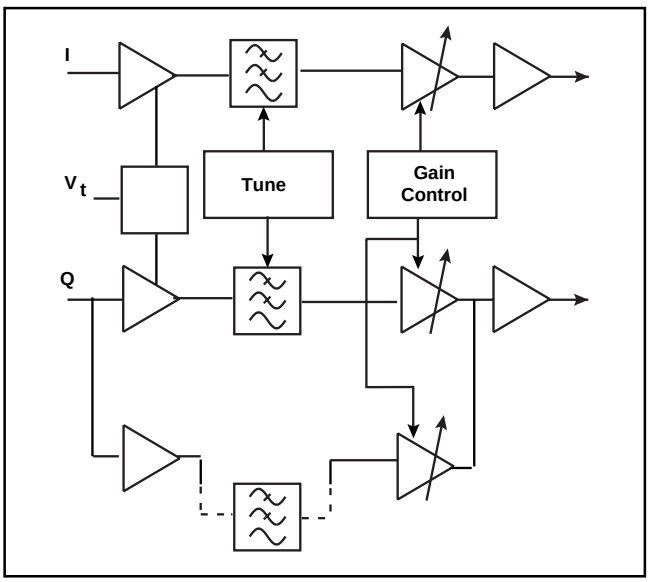


Fig. 2 Block diagram

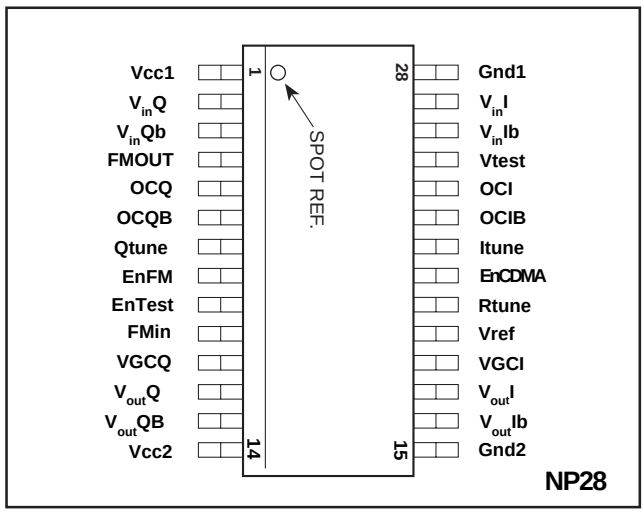


Fig.1 Pin connections - top view

FEATURES

DC

- Low voltage operation (2.7V to 3.6V)
- Low power operation (CDMA: 7mA typ, FM: 3.4mA typ)
- Sleep mode (typically 60µA)

FM Path (AMPS/TDMA)

- Ceramic filter driver (nominal 450kHz)
- Variable gain amplifiers
- 47dB nominal voltage gain
- ± 10dB gain adjust range
- Low gain variation over temperature and supply (< ± 0.5dB)

ORDERING INFORMATION

NEPTUNE-1/KG /NP1S - Tubes

NEPTUNE-1/KG/NP1T - Tape and reel

Filter can be tuned to other frequencies by changing value of resistor to pin 20 (R tune)

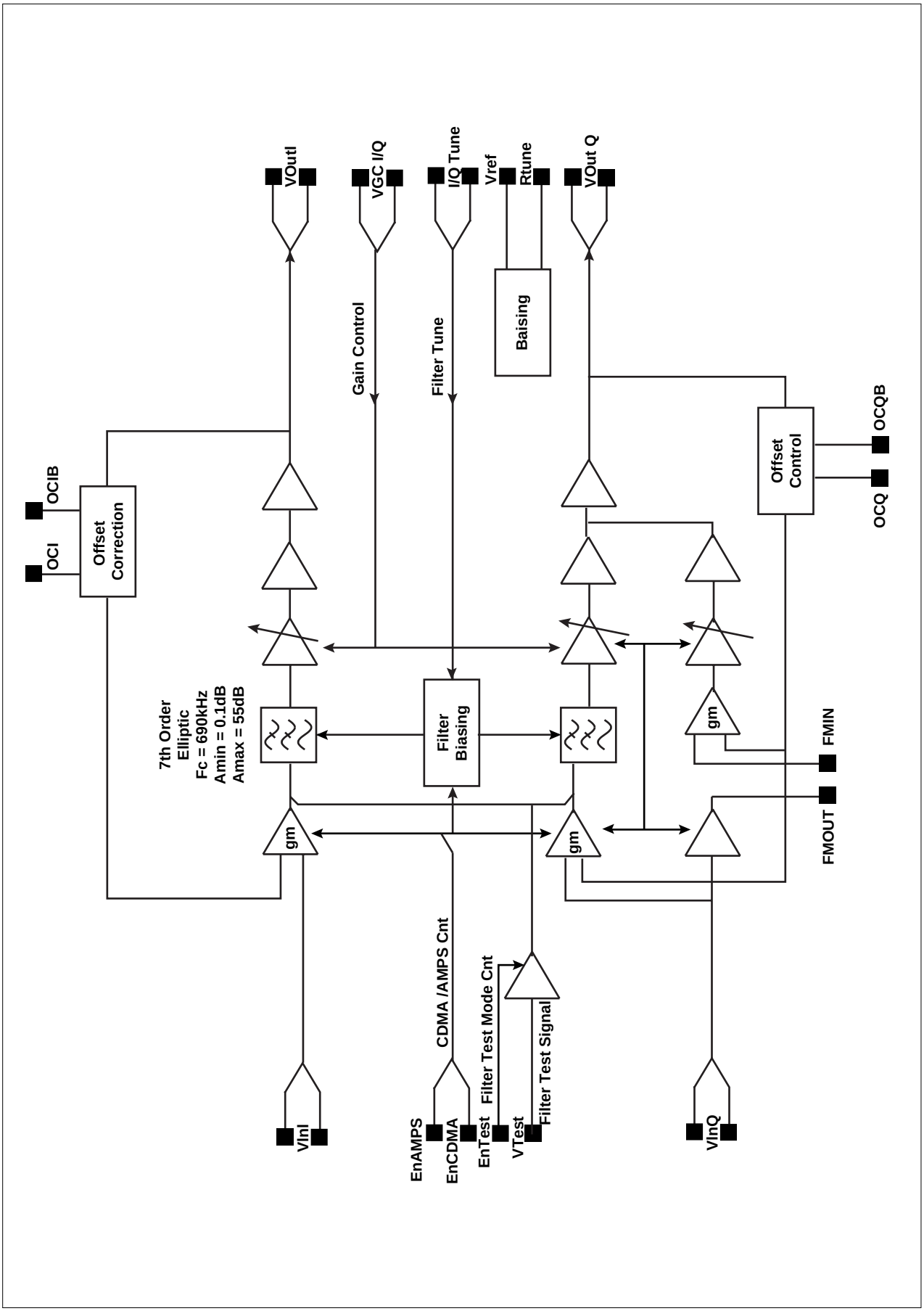


Fig. 3 Neptune detailed block diagram

ELECTRICAL CHARACTERISTICS (Power Control)

	Control Line			
Description	**EnCDMA**	**EnFM**	**EnTest**	**Comments**
Sleep Mode	0	0	0	All circuits powered down
CDMA Mode	1	0	0	Biasing & CDMA signal path on
FM Mode	0	1	0	Biasing &FM signal path on
CDMA Filter Test Mode	1	0	1	Biasing, test & CDMA signal path on, excluding CDMA modes input amplifier
Disallowed Modes	0	X	1	
	1	1	X	

ELECTRICAL CHARACTERISTICS (DC specification)

T_{AMB} = -30°C to +70°C, V_{CC} = +2.7 to +3.6V. These characteristics are guaranteed by either production test or design. They apply within the specified ambient temperature and supply voltage ranges unless otherwise stated.

Characteristic	**Value**			**Units**	**Conditions**
	Min	**Typ**	**Max**		
Supply Voltage	2.7	3.0	3.6	V	Vcc
Supply Voltage Drift	-50		50	mV	Vdrift
Operating temperature	-30	27	70	°C	Tamb
Current Consumption *Note 1, 2					
Icc1 + Icc2, Sleep		0.06	0.15	mA	Sleep Mode
FM &CDMA					FM/CDMA/Test 'off'
Icc1 + Icc2, FM Mode		3.6	5.2	mA	FM signal path 'on'
					CDMA signal path 'off'
					Test signal path 'off'
Icc1 + Icc2, CDMA Mode		7.3	12	mA	CDMA signal path 'on' Note1
					FM signal path 'off'
					Test signal path 'off'
Icc1 + Icc2, Test Mode		7.3	12	mA	CDMA signal path 'on' Note1
					FM signal path 'off'
					Test signal path 'off'
Turn off time		1.0		µs	Icc1 = Icc2 to be <10% of value in CDMA/FM mode
On time			300	µs	Fully settled

Note: 1 When both filters are tuned to the 8dB cut off frequency, current is a function of frequency

2. R_{tune} is 18kohms for 720kHz @ -8dB

3. Filter may be tuned to other frequencies by varying R_{tune}

ELECTRICAL CHARACTERISTICS (General AC specification) FM MODE

T_{AMB} = -30°C to +70°C, V_{CC} = +2.7 to +3.6V. These characteristics are guaranteed by either production test or design. They apply within the specified ambient temperature and supply voltage ranges unless otherwise stated.

Characteristic	Value			Units	Conditions
	Min	Typ	Max		
Frequency Range					
Input frequency range		450		kHz	Set by external filter 10K-1MHz
Voltage gain					
VinQ/QB to VOutQ/QB					Assume 3dB insertion loss in external ceramic filter. ZloadExt = 50kΩ, parallel 5pF on VoutQ/QB
Q Voltage gain 'High gain'	55	62	70	dB	'VGGQ' ≥ 2.0V
Q Voltage gain 'nominal gain'		50	55	dB	'VGGQ' = 1.1V
Q Voltage gain 'low gain'	24	32	46	dB	'VGGQ' ≤ 0.5V
Gain Variation over temperature & voltage drift	-1		+1	dB	VGCQ = constant voltage
Output Amplitude balance VoutQ/VoutQB	-0.5		0.5	dB	
Phase linearity			1.0	deg	Deviation from linear phase over 450kHz = /-25kHz (excluding external filter)
Noise					
Output referred maximum integrated noise 10Hz to 50MHz @ 27C					At 27C, assume 3dB insertion loss in external ceramic filter. Integrated from 10Hz to 50MHz. Source impedance 2kohm differential
Voltage Gain ≥ 47dB			14.0 x Vgain	μVrms	
Voltage Gain ≤ 47dB			3.1	mVrms	
1dB Compression					
Output at 1dB Compression	1.5	1.9		Vpk-pk	Measured differentially
Intermodulation					
Input referred intermodulation product					Out of band interferers un-modulated fc+60kHz @ -14dBV, 200mVrms fc+120kHz @ -44dBV, 5mVrms
ALL Conditions	-82			dBV	
	79.3			μVrms	
Room Temperature		-91		dBV	
		28.1		μVrms	
Offset loop Correction					
Amplifier offset control settling time during on/off cycling			10.0	ms	Settling to within 5mV of the final voltage
Input Impedances					
VInQ/VInQB		5.0		kΩ	Balanced @ 450kHz, 27°C
FMin		1.0		kΩ	Single ended @ 450kHz
Output Impedances					
VOutQ/VOutQB		1.0		kΩ	Balanced external differential AC coupled load: 50kΩ parallel 10pF
FMout	0.8	1.0	1.2	kΩ	Single ended

ELECTRICAL CHARACTERISTICS (General AC specification) CDMA MODE

T_{AMB} = -30°C to +70°C, V_{CC} = +2.7 to +3.6V. These characteristics are guaranteed by either production test or design. They apply within the specified ambient temperature and supply voltage ranges unless otherwise stated.

Characteristic	Value			Units	Conditions
	Min	Typ	Max		
Filter Characteristic					
Filter Type					EIIiptic 7th order, 0.1dB ripple. Continuously tunable, set by ext resistor and voltage
Passband edge tolerance over supply drift & temperature	706	720	735	kHz	8dB bandwidth (once filter tuned)
Passband edge (filters un-tuned)	540	720	900	kHz	8dB bandwidth R_{tune} = 18kΩ
Stop band attenuation	50	55		dB	900kHz to 10MHz
I/Q bandwidth matching (Itune = Vtune) = 1volt			4.0	%	I (8dB BW) -Q (8dB BW) / I (8dB BW) +Q (8dB BW)
Inband Gain ripple		0.5	0.7	dB	2kHz to 535kHz
Max signal - Min signal			1	dB	535 - 630kHz
I/Q Phase balance			2.0	deg	Average taken from 2kHz to 630kHz
Voltage gain I & Q, VinI/IB to VoutI/IB VinQ/QB to VOutQ/QB					Zload = 10kΩ
I & Q Voltage gain 'High gain'	44	49		dB	'VGCI' & 'VGCQ' = 2.0V
I & Q Voltage gain 'nominal gain'	32	34	38	dB	'VGCI' & 'VGCQ' =1.0V
I & Q Voltage gain 'low gain'		18	24	dB	'VGCI & 'VGCQ' = 0.5V
I, Q Gain imbalance	-1.0		1.0	dB	Without adjustment VGCI=VGCQ
Gain variation over temperature & Supply voltage drift	1		1	dB	
Noise					
Output referred maximum integrated noise 10Hz to 50MHz @ 27C					At 27C Input terminated with 2kohm differentially. Integrated from 10Hz to 50MHz
Voltage Gain ≥ 34dB			0.110 xV gain	mVrms	
Voltage Gain ≤ 34dB			5.0	mVrms	
1dB Compression (output limiting)					
Output at 1dB Compression	1.5	1.9		Vpk-pk	Measured across external differential load: 10kΩ parallel 10pF
Out of band signal at input causing 1dB of inband compression					100kHz inband tone.
900kHz out of band tone		220		mVrms	25°C
1.25MHz out of band tone		350		mVrms	25°C

ELECTRICAL CHARACTERISTICS (General AC specification)

T_{AMB} = -30°C to +70°C, V_{CC} = +2.7 to +3.6V. These characteristics are guaranteed by either production test or design. They apply within the specified ambient temperature and supply voltage ranges unless otherwise stated.

Characteristic	Value			Units	Conditions
	Min	Typ	Max		
Intermodulation					
Input referred intermodulation product					Out of band interferers : 900kHz @ 125mVrms, un-modulated 1700kHz @ 40mVrms, un-modulated
All conditions	-72 0.251			dBV mVrms	
At 25°C		-79 0.112		dBV mVrms	At 25°C
Input referred intermodulation product					Out of band interferers: 1.25MHz @125mVrms, un-modulated, 2.05MHz @ 40mVrms, un-modulated
All conditions	-72 0.251			dBV mVrms	
At 25°C		-79 0.112		dBV mVrms	
Offset loop Correction					
Amplifier offset control settling time during on/off cycling			10.0	ms	Settling to within 8mV of the final Voltage Forward gain = 34dB
Input Impedance					
VInQ/VInQB & VInI/VInIB		5.0		kΩ	Balanced, 27°C
Output Impedance					
VOutQ/VOutQB		1.0		kΩ	Balanced External differential AC coupled load:10kΩ parallel 10pF

PIN DESCRIPTION

Pin No	Pin Name	I/O	Description
1	Vcc1	P	Supply
2	VinQ	I	Q channel CDMA/FM input
3	VinQB	I	Q channel CDMA/FM input (balanced)
4	FMOUT	O	FM output to external bandpass filter
5	OCQ		Offset control (Q channel)
6	OCQB		Offset control (Q channel balanced)
7	QTune	I	Q filter tuning control
8	EnFM	I	FM mode (Amps/TDMA) power enable
9	EnTest	I	Test/Receive input switch
10	FMin	I	FM input from external filter
11	VGCQ	I	Gain control for Q channel
12	VOutQ	O	Q channel CDMA/FM output
13	VOutQB	O	Q channel CDMA/FM output (balanced)
14	Vcc2	P	Supply
15	Gnd2	P	Ground
16	VOutIB	O	I channel CDMA output (balanced)
17	VOutI	O	I channel CDMA output
18	VGCI	I	Gain control for I channel
19	Vref		Reference voltage decouple
20	Rtune		Precision resistor for current definition (filter tune range)
21	EnCDMA	I	CDMA mode power enable
22	Itune	I	I filter tuning control
23	OCIB		Offset control (I channel balanced)
24	OCI	I	Offset control (I channel)
25	Vtest	I	Input of test mode signal for tuning operation
26	VinIB	I	I channel CDMA input (balanced)
27	VinI	I	I Channel CDMA input
28	Gnd1	P	Ground

Circuit Description

The block diagram NEPTUNE is shown in Fig. 3

CDMA mode:-

Two tunable active low-pass gyrator filters for CDMA applications are designed with balanced I /Q inputs and outputs. The filter itself is a 7th order elliptic type with corner frequency designed at 690kHz for best stopband attenuation and minimal phase error (in the overall system) . The two filters can be independently tuned over a wide range (530KHz to 910KHz) the centre of the range being set by the external resistor on pin 20. Variable gain stages after the filter provide a gain control capability to compensate for component gain variations. Overall, each of the CDMA I/Q channels has 34dB nominal voltage gain with a minimum +/-10dB gain adjust range. Separate I/Q frequency gain and tuning functions are built into the circuit. Gain and tuning control for the I and Q are separate but can be combined into one if the gain imbalance is proven to satisfy the system requirements.

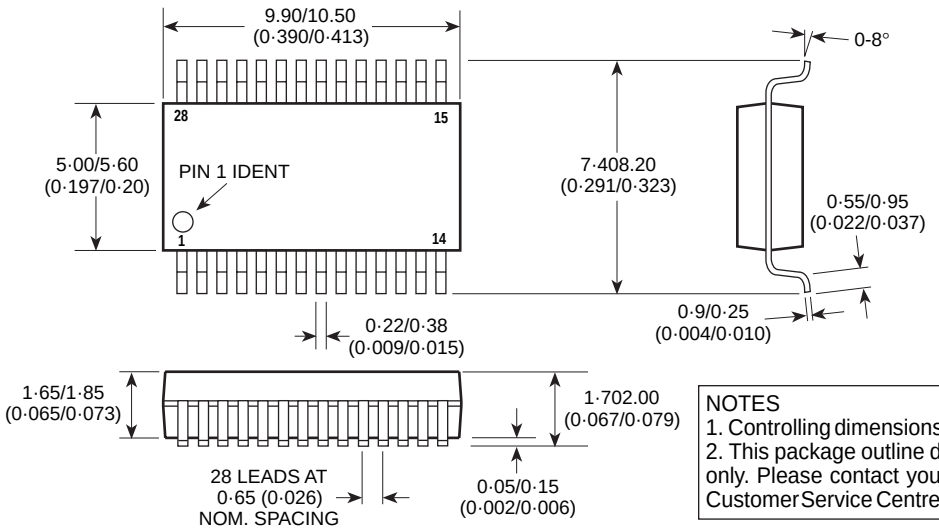
FM mode:-

In this design, the FM mode (AMPS/TDMA) path uses an external ceramic filter to provide a 30kHz bandpass filtering function. The FM path has 47dB nominal voltage gain with a minimum of +/-10dB adjustable range. The interface to the external ceramic filter is designed for a single ended operation input and output .

In both CDMA and FM modes, signal inputs and outputs are balanced. Due to the high gain, AC coupling is recommended. Switching between the CDMA and FM modes can be achieved by changing the voltages to the control pins. The CDMA /FM mode selection pins are separate and each mode is guaranteed 'on' when supplied with 2V or more and off when supplied with 0.5V or less. An external (220nF) decoupling capacitor is connected across OCQ and OCQB pins or OCI and OCIB pins for the DC offset control. For the internal voltage setup, (220nF + 1μF) decoupling capacitors should be connected from 'Vref' to ground. A resistor is used to control the current source for the gyrator filters. This resistor should be placed between 'Rtune' and ground and should have a low temperature coefficient (<100ppm) with a tolerance of <±5%. 18Kohms will tune the filter to 720KHz.

PACKAGE DETAILS

Dimensions are shown thus: mm (in). For further package information, please contact your local Customer Service Centre.



NOTES
1. Controlling dimensions are millimetres.
2. This package outline diagram is for guidance only. Please contact your Mitel Semiconductor Customer Service Centre for further information.

28-LEAD SHRUNK MINIATURE PLASTIC DIL (SSOP) - NP28

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