Convert Latitude and Longitude to Lambert Conformal Conic Projection Co-ordinates (SPCS)

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Line	Instruction	Display	User Instructions
N001	LBL N		LBL N
N002	CLSTK		CLEAR 5
N003	FS? 10		FLAGS 3 .0
N004	GTO N008		
N005	SF 1		FLAGS 1 1
N006	SF 10		FLAGS 1 .0
N007	GTO N009		
N008	CF 1		FLAGS 2 1
N009	LAT–LONG 2 LCC		(Key in using EQN RCL L, RCL A, etc.)
N010	PSE		PSE
N011	CL x		CLEAR 1
N012	STO F		STO F
N013	STO L		STO L
N014	STO P		STO P
N015	STO Q		STO Q
N016	STO C		STO C
N017	STO D		STO D
N018	STO G		STO G
N019	STO H		STO H
N020	6378137		a value for ellipsoid (WGS84/NAD83)
N021	STO A		STO A
N022	0.00669438		e^2 value for ellipsoid (WGS84/NAD83)
N023	STO E		STO E
N024	CHECK–ENTER A		(Key in using EQN RCL C, RCL H, etc.)
N025	PSE		PSE
N026	INPUT A		INPUT A
N027	CHECK–ENTER E		(Key in using EQN RCL C, RCL H, etc.)
N028	PSE		PSE
N029	INPUT E		INPUT E
N030	RCL E		
N031	√x		
N032	STO O		STO O
N033	CHK—NTR LAT 0		(Key in using EQN RCL C, RCL H, etc.)
N034	PSE		PSE
N035	INPUT P		INPUT P
N036	CHK—NTR LONG 0		(Key in using EQN RCL C, RCL H, etc.)
N037	PSE		PSE
N038	INPUT Q		INPUT Q

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Line	Instruction
N039	STD PARALLEL 1
N040	PSE
N041	INPUT C
N042	STD PARALLEL 2
N043	PSE
N044	INPUT D
N045	CHK—NTR E 0
N046	PSE
N047	INPUT G
N048	CHK—NTR N 0
N049	PSE
N050	INPUT H
N051	RCL P
N052	HMS→
N053	STO P
N054	RCL Q
N055	HMS→
N056	STO Q
N057	RCL C
N058	HMS→
N059	STO C
N060	RCL D
N061	HMS→
N062	STO D
N063	ENTER PT LAT
N064	PSE
N065	INPUT F
N066	ENTER PT LONG
N067	PSE
N068	INPUT L
N069	RCL L
N070	HMS→
N071	STO L
N072	RCL F
N073	HMS→
N074	STO F
****	Calculate m_2
N075	RCL D
N076	STO Z
N077	XEQ N209
N078	RCL Z
N079	STO S
****	Calculate m_1
N080	RCL C
N081	STO Z

Line	Instruction
N082	XEQ N209
N083	RCL Z
N084	STO R
****	Calculate t_1
N085	RCL C
N086	STO Z
N087	XEQ N222
N088	RCL Z
N089	STO U
****	Calculate t_2
N090	RCL D
N091	STO Z
N092	XEQ N222
N093	RCL Z
N094	STO V
****	Calculate t_0
N095	RCL P
N096	STO Z
N097	XEQ N222
N098	RCL Z
N099	STO T
****	Calculate n
N100	RCL R
N101	LN
N102	RCL S
N103	LN
N104	—
N105	RCL U
N106	LN
N107	RCL V
N108	LN
N109	—
N110	÷
N111	STO N
****	Calculate F
N112	RCL R
N113	RCL÷ N
N114	RCL U
N115	RCL N
N116	y^x
N117	÷
N118	STO J
****	Calculate r_0
N119	RCL A
N120	RCL× J

Line	Instruction
N121	RCL T
N122	RCL N
N123	y^x
N124	×
N125	STO M
****	Calculate θ
N126	RCL L
N127	RCL— Q
N128	RCL× N
N129	STO K
****	Calculate r
N130	RCL F
N131	STO Z
N132	XEQ N222
N133	RCL Z
N134	RCL N
N135	y^x
N136	RCL× J
N137	RCL× A
N138	STO B
****	Calculate X and Y
N139	RCL K
N140	SIN
N141	RCL× B
N142	STO X
N143	RCL M
N144	RCL K
N145	COS
N146	RCL× B
N147	—
N148	STO Y
N149	RCL G
N150	STO+ X
N151	RCL H
N152	STO+ Y
****	Calculate scale factor
N153	1
N154	RCL F
N155	SIN
N156	x^2
N157	RCL× E
N158	—
N159	√x
N160	RCL A
N161	x < > y

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Line	Instruction
N162	÷
N163	RCL F
N164	COS
N165	×
N166	RCL÷ N
N167	RCL÷ B
N168	1/x
N169	STO W
****	Calculate γ
N170	RCL K
N171	→HMS
N172	STO K
****	Show results
N173	RESULTS
N174	PSE
N175	EASTING
N176	PSE
N177	VIEW X
N178	NORTHING
N179	PSE
N180	VIEW Y
N181	GRID CONV
N182	PSE
N183	VIEW K
N184	PT SCALE FACT
N185	PSE
N186	VIEW W
****	Check for next pt.
N187	0
N188	STO Z
N189	NEXT PT [0—1]
N190	PSE
N191	INPUT Z

Line	Instruction
N192	RCL Z
N193	x = 0 ?
N194	GTO N204
N195	NEW ZONE [0—1]
N196	PSE
N197	0
N198	STO Z
N199	INPUT Z
N200	RCL Z
N201	x = 0 ?
N202	GTO N063
N203	GTO N024
****	End of program
N204	PROGRAM END
N205	PSE
N206	FS? 1
N207	CF 10
N208	RTN
****	Subroutines
****	Compute m
N209	RCL Z
N210	COS
N211	RCL Z
N212	SIN
N213	x^2
N214	RCL× E
N215	1
N216	x < > y
N217	—
N218	√x
N219	÷
N220	STO Z
N221	RTN

Line	Instruction
****	Compute t
N222	1
N223	RCL Z
N224	SIN
N225	RCL× O
N226	—
N227	RCL Z
N228	SIN
N229	RCL× O
N230	1
N231	+
N232	÷
N233	RCL O
N234	2
N235	÷
N236	y^x
N237	45
N238	RCL Z
N239	2
N240	÷
N241	—
N242	TAN
N243	x < > y
N244	÷
N245	STO Z
N246	RTN

Notes

(1) The program should be run in RPN mode, as results in ALG mode are unknown.

(2) Latitudes and longitudes should be entered in HP notation, i.e., DDD.MMSS. The grid convergence is displayed in HP notation.

(3) The program may be used for any Lambert Conformal Conic projection, if the appropriate parameters are known. Similarly, any ellipsoid may be used, if its a and e^2 parameters are known. Parameters for a wide range of ellipsoids and all SPCS Lambert zones are included at the end of this document.

(4) Latitudes in the southern hemisphere are negative. Longitudes west of Greenwich are negative, i.e., all longitudes in North America. It is critical to enter the correct sign in calculator when entering values.

(5) Lines with **** are comments only, and should not be entered into the calculator. They are there to make program entry a little easier.

(6) This program is long and often appears to be a stream of meaningless commands. This means that it may be more prone to errors when being entered. It is suggested that the program be entered using the given constants, tested (and the checksum checked), and when it is satisfactory, the values for the zone that are set to zero at the start of the program can be changed to those most suitable for the bulk of the expected work. See the **Localization** section at the end of the document.

(7) When working in SPCS 1927, there are some small differences in Northings between this program and the NGS conversion program. This may be caused by a different method of computing the distance from the pole in days gone by (see the discussion in the **Theory** section). The differences are small (less than 0.25 inch in all places tested thus far) and appear to be larger the further the point is from the pole. The conversions in SPCS 1983 agree to 0.001 m, which is the finest value the NGS program provides.

(8) The scale factor is exactly 1.0000 when the point is on the standard parallels. It is less than 1.0000 between the standard parallels, and greater than 1.0000 outside the standard parallels.

Theory

Converting from geographical co-ordinates (latitude and longitude) to cartesian co-ordinates on a Lambert Conformal Conic projection is a straightforward transformation, if somewhat long-winded. The following is derived from Snyder's *Map Projections – A Working Manual*.

If we are working on the ellipsoid, which we really have to do for most cases and certainly for the SPCS, we need the following information in order to convert geographical co-ordinates into grid co-ordinates: a, e^2, ϕ_1, ϕ_2, ϕ_0, λ_0, ϕ and λ. We know a and e^2 for the particular ellipsoid being used, and the fixed latitude and longitude values are already determined for every SPCS zone. The details are provided for all SPCS Lambert Zones at the end of this discussion.

(Note that the SPCS 27 has co-ordinates in US Survey feet, and uses the Clarke 1866 ellipsoid. The SPCS 83 has co-ordinates in meters, and uses the GRS80 spheroid, which effectively is the same as WGS-84. Some states have either the US Survey foot or the International foot as alternative distance units; check which one is in use in the state you are working in at any particular time. Note that there is a datum shift between the two systems (1927 and 1983) as well, and that you cannot really do a direct linear shift between them.

With the basic information, we can compute the co-ordinates as follows:

$$x = r \sin \theta$$

$$y = r_0 - r \cos \theta$$

then use

$$E = E_0 + x$$

$$N = N_0 + y$$

where the following formulae are used. Note that subscripts 0, 1 or 2 imply the use of specific values of ϕ in the formulae for r, m and t at the appropriate places.

The example of r_0 is given below. The terms t, m and F are used only to simplify computation and do not imply any real (or readily apparent) physical quantity or value.

$$r = a F t^n$$

$$\theta = n (\lambda - \lambda_0)$$

$$r_0 = a F t_0^n$$

$$n = \frac{\ln m_1 - \ln m_2}{\ln t_1 - \ln t_2}$$ (constant of the projection or cone)

$$m = \frac{\cos \phi}{\sqrt{1 - e^2 \sin^2 \phi}}$$

$$t = \frac{\tan\left(\frac{\pi}{4} - \frac{\phi}{2}\right)}{\left(\frac{1 - e \sin \phi}{1 + e \sin \phi}\right)^{\frac{e}{2}}}$$

or $$t = \sqrt{\left(\left(\frac{1 - \sin \phi}{1 + \sin \phi}\right)\left(\frac{1 + e \sin \phi}{1 - e \sin \phi}\right)^{e}\right)}$$

$$F = \frac{m_1}{n\, t_1^n}$$

$$k = \frac{n\ r}{\nu \cos \phi}$$ (scale factor at the latitude ϕ)

where ν = the radius of the ellipsoid at the parallel of latitude ϕ

$$\gamma = \theta$$ (grid convergence at the point)

Note that n, F and r_0 are constants for a particular map or SPCS zone and only need to be computed once.

When computing with these values, you will get results slightly different from those in the published tables for SPCS 27 (although many of these are out of print). The discrepancy is of the order of 20-30 meters, which is relatively small considering the r distances coming from the pole, and the relative error in a SPCS zone is quite small. The reason for this is that for calculating convenience 70 years ago, when the tables were developed, the tables were, in effect, calculated using the following variant of t, i.e.

$$t = \tan\left(\frac{\pi}{2} - \frac{\phi_g}{2}\right)$$

where ϕ_g is the geocentric latitude, also able to be expressed by

$$\phi_g = \arctan((1 - e^2) \tan \phi)$$

t is actually the cotangent of half the co-latitude of the conformal latitude, χ, which is derived by assuming that a sphere was used as a kind of substitute for the ellipsoid in some calculations (see Snyder for greater details of this, if you are interested). As it happens, the expansions for χ and ϕ_g are numerically very nearly the same. However, the small differences still exist in the SPCS 27 tables. There are other smaller differences caused by the slightly lower precision of older desk-top calculating machines, compared to modern equipment, and the adaptation of formulae to suit these machines. However, these discrepancies are pretty small. This program does not take account of these differences, and so there are small differences between the results here (in the Northings only) and the results from the NGS conversion program. These appear to be less than 0.25 inch anywhere that has been tested thus far.

As you can see from the tables below, most of the SPCS Lambert zones adopt ϕ_0 as having a Y or N value of zero. It is chosen so as to be well south of the limits of the zone. For most of the Lambert zones, the central meridian gets a value of 2,000,000 feet (SPCS 27), and a range of meter values for SPCS 83. See the tables below for exact data.

Sample Computations

Example 1

Using the SPCS 1983 ($a = 6{,}378{,}137$ m, $e^2 = 0.006\,694\,3800$), the following results are obtained.

Ohio North Zone, 3401: True Origin: $\phi_0 = 39° 40'$, $\lambda_0 = -82° 30'$;
Standard Parallels: $\phi_1 = 40° 26'$, $\phi_2 = 41° 42'$;
False Origin: $E_0 = 600{,}000.000$ m, $N_0 = 0.000$ m.

Latitude = 40° 05' 30" Longitude = –83° 10' 20"

Easting (E) = 542,668.995 m Northing (N) = 47,416.966 m

Grid Convergence (γ) = –0° 26' 29.82" Point Scale Factor (k) = 1.000 082 97

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Example 2

Using the SPCS 1927 (a = 20,925,832.2 ft, e^2 = 0.006 768 66), the following results are obtained.

Ohio North Zone, 3401: True Origin: ϕ_0 = 39° 40', λ_0 = –82° 30';
Standard Parallels: ϕ_1 = 40° 26', ϕ_2 = 41° 42';
False Origin: E_0 = 2,000,000.000 ft, N_0 = 0.000 ft.

Latitude = 40° 05' 30" Longitude = –83° 10' 20"

Easting (E) = 1,811,901.577 ft Northing (N) = 155,564.399 ft

Grid Convergence (γ) = –0° 26' 29.82" Point Scale Factor (k) = 1.000 082 97

Note: the NGS conversion program gave the same results, except for the Northing, which it gave as 155,564.393, a difference of 0.006 ft (about 0.07 inches). Testing other points in this zone indicate a consistent difference of about this amount. This may be because of the different method of computing the distances from the pole (r and r_0) in earlier computations of the zones.

Example 3

Using the SPCS 1927 (a = 20,925,832.2 ft, e^2 = 0.006 768 66), the following results are obtained.

California III Zone (0403), SPCS 1927, ϕ_0 = 36° 30', λ_0 = –120° 30';
ϕ_1 = 37° 04', ϕ_2 = 38° 26';
E_0 = 2,000,000.000 ft, N_0 = 0.000 ft.

Latitude = 37° 25' 40" Longitude = –119° 45' 20"

Easting (E) = 2,216,169.136 ft Northing (N) = 338,664.251 ft

Grid Convergence (γ) = 0° 27' 20.8" Point Scale Factor (k) = 0.999 945 01

Note: The NGS conversion program give the same results, except for the Northing, which it gives as 338,664.238 ft, a difference of 0.013 ft (about 0.16 inches). Testing other points in this zone indicate a consistent difference of about this amount. This may be because of the different method of computing the distances from the pole (r and r_0) in earlier computations of the zones.

Example 4

Using the SPCS 1983 (a = 6,378,137 m, e^2 = 0.006 694 3800), the following results are obtained.

California III Zone (0403), SPCS 1983, ϕ_0 = 36° 30', λ_0 = –120° 30';
ϕ_1 = 37° 04', ϕ_2 = 38° 26';
E_0 = 2,000,000.000 m, N_0 = 500,000.000 m.

Latitude = 37° 25' 40" Longitude = –119° 45' 20"

Easting (E) = 2,065,886.861 m Northing (N) = 603,227.485 m

Grid Convergence (γ) = 0° 27' 20.8" Point Scale Factor (k) = 0.999 945 01

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Running the Program

Press XEQ N, then press ENTER to start the program. The calculator briefly displays LAT—LONG 2 LCC, then briefly shows CHECK—ENTER A. The program then stops and displays the prompt for entering the semi-major axis value, while displaying the current default value:

A?
6,378,137.0000 (This is for GRS80/WGS84/NAD83)

If you are happy with this value for the semi-major axis of the ellipsoid, press R/S to continue. Otherwise. Key in a different value (for a different ellipsoid) and press R/S to continue.

The calculator briefly displays CHECK—ENTER E. The program then stops and displays the prompt for entering the eccentricity of the ellipsoid, e:

E?
0.00669438 (This is for GRS80/WGS84/NAD83)

If this value for the eccentricity is correct, press R/S to continue. Otherwise, key in a different value (for a different ellipsoid) and press R/S to continue.

The calculator briefly displays CHK—NTR LAT 0. The program then stops and displays the prompt for entering the origin latitude for the co-ordinate, ϕ_0:

P?
0.0000

Key in the correct latitude in HP notation (DDD.MMSS), and press R/S to continue. In this case, key in 39.40 for Ohio North.

The calculator briefly displays CHK—NTR LONG 0. The program then stops and displays the prompt for entering the longitude of the central meridian of the projection, λ_0. Note that in the western hemisphere, this will be a negative value, and should be in HP notation (DDD.MMSS).

Q?
0.0000

Key in the correct longitude, in HP notation and remembering the sign, then press R/S to continue. In this case, key in –82.30 for Ohio North

The calculator briefly displays STD PARALLEL 1. The program then stops and displays the prompt for entering the latitude of one of the standard parallels for the projection, ϕ_1. The value should be entered in HP notation.

C?
0.000000

Key in the correct value and press R/S to continue. In this case, key in 40.26 and press R/S to continue.

The calculator briefly displays STD PARALLEL 2. The program then stops and displays the prompt for entering the latitude of the other standard parallel for the projection, ϕ_2. The value should be entered in HP notation.

D?
0.000000

Key in the correct value and press R/S to continue. In this case, key in 41.42 and press R/S to continue.

The calculator briefly displays CHK—NTR E 0. The program then stops and prompts for the false easting value, or the easting offset. This is the value of the easting at the central meridian (λ_0), denoted E_0.

G?
0.0000

Key in the correct value, and press R/S to continue. In this case, key in 600000.0 and press R/S.

The calculator briefly displays CHK—NTR N 0. The program then stops and prompts for entry of the false northing value, or the northing offset. This is the value of the northing co-ordinate at ϕ_0, λ_0.

H?
0.0000 (This is for UTM)

If this is the correct value (for some zones, it is zero), press R/S to continue. If a different value is desired, key in the value and press R/S. In this case, just press R/S. This is the N_0 value for Ohio North.

The calculator briefly displays ENTER PT LAT. The program stops and displays the prompt for entering the latitude of the point to be converted. This should be entered in HP notation.

F?
0.0000

Key in the latitude of the point in HP notation and press R/S to continue. In this case, key in 40.0530 and press R/S.

The calculator briefly displays ENTER PT LONG. The program then stops and displays the prompt for entering the longitude of the point to be converted. This should be entered in HP notation.

L?
0.0000

Key in the longitude of the point in HP notation and press R/S to continue. In this case, key in —83.1020 and press R/S/

The program displays RUNNING for a short while, then displays RESULTS briefly, followed by EASTING briefly. The program then stops and displays the easting value of the point. In this case, the calculator displays:

X=
542,662.995

This is the easting of the point, in this case in meters. Press R/S to continue. The calculator briefly displays NORTHING, then stops and displays the northing value of the point. In this case, the calculator displays:

Y=
47,416.966

This is the northing of the point, in this case in meters. Press R/S to continue. The calculator briefly displays GRID CONV, then stops and displays the grid convergence value in HP notation. In this case, the calculator displays:

K=
—0.262981976

This is the grid convergence in HP notation, and is —0° 26' 29".82 in more conventional notation. Press R/S to continue. The calculator briefly displays PT SCALE FACT, then stops and displays the point scale factor of the point on the Transverse Mercator projection. In this case, the calculator displays:

W=
1.00008297

This is the point scale factor. Press R/S to continue.

You now have the choice of running one or more additional points. The calculator briefly displays NEXT PT [0—1], then stops and displays the prompt for answering questions:

Z?
0.0000

If you want to quit the program, just press R/S. If you want to enter more points, key in 1 and press R/S. In this case, the calculator then prompts to see if you want to use the same parameters. The calculator briefly displays NEW ZONE [0—1], then stops at the question prompt:

Z?
0.0000

If you want to go to a new zone, key in 1 and press R/S, and the calculator will take you to the point where you can change any of the values (Point A above), starting with the ellipsoid parameters. If you want to work in the same zone already entered, just press R/S, and the program will take you to “Point B” and prompt for the latitude of the point to be converted, and continue from there. You can go around the program as many times as necessary.

When you choose to end the program, the calculator briefly displays PROGRAM END and then comes to an end, returning to the point from which it was called, or to normal operations.

Storage Registers Used

A	Semi-major axis of the ellipsoid being used, a
B	r, distance from the pole to the point
C	ϕ_1, one of the two standard parallels of the projection
D	ϕ_2, one of the two standard parallels of the projection
E	Eccentricity of the ellipsoid, e^2
F	ϕ, latitude of the point to be converted
G	E_0, the false easting or easting offset
H	N_0, the false northing, or northing offset, at ϕ_0, λ_0
J	F, an internal computed value

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K θ, the angle between the line from the pole to the point, and the central meridian, also the grid convergence

L λ, longitude of the point to be converted

M r_0, distance from the pole to ϕ_0

N n, the constant of the projection or cone

O e, the square root of the eccentricity of the ellipsoid.

P ϕ_0, the latitude of the co-ordinate origin on the projection

Q λ_0, the central meridian of the projection

R m_1, an internal computed value

S m_2, an internal computed value

T t_0, an internal computed value

U t_1, an internal computed value

V t_2, an internal computed value

W point scale factor, k

X Easting co-ordinate of converted point

Y Northing co-ordinate of converted point

Z Response variable for checking if another point

Statistical Registers: not used

Labels Used

Label **N** Length = 989 Checksum = F78C

Use the length (LN=) and Checksum (CK=) values to check if program was entered correctly. Use the sample computation to check proper operation after entry.

Flags Used

Flags 1 and 10 are used by this program. Flag 10 is set for this program, so that equations can be shown as prompts. Flag 1 is used to record the setting of Flag 10 before the program begins. At the end of the program, Flag 10 is reset to its original value, based on the value in Flag 1.

Parameters for the Computations

State Plane Co-ordinate System (SPCS) 1983

Several US states use the Lambert Conformal Conic projection for SPCS 1983. The various parameters for each zone in the 1983 system are given in the table below. Use these parameters with the program, together with the GRS80/WGS84/NAD83 ellipsoid parameters, in meters.

	Standard Parallels		**Origin Longitude**	**Origin Latitude**	**False East**	**False North**
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (m)	N_0 (m)
Alaska						
Zone 10	51° 50'	53° 50'	176° 00'	51° 00'	1,000,000.00	0.00
Arkansas						
North	34° 56'	36° 14'	92° 00'	34° 20'	400,000.00	0.00
South	33° 18'	34° 46'	92° 00'	32° 40'	400,000.00	400,000.00
California						
I	40° 00'	41° 40'	122° 00'	39° 20'	2,000,000.00	500,000.00
II	38° 20'	39° 50'	122° 00'	37° 40'	2,000,000.00	500,000.00
III	37° 04'	38° 26'	120° 30'	36° 30'	2,000,000.00	500,000.00
IV	36° 00'	37° 15'	119° 00'	35° 20'	2,000,000.00	500,000.00
V	34° 02'	35° 28'	118° 00'	33° 30'	2,000,000.00	500,000.00
VI	32° 47'	33° 53'	116° 15'	32° 10'	2,000,000.00	500,000.00
Colorado						
North	39° 43'	40° 47'	105° 30'	39° 20'	914,401.83	304,800.61
Central	38° 27'	39° 45'	105° 30'	37° 50'	914,401.83	304,800.61
South	37° 14'	38° 26'	105° 30'	36° 40'	914,401.83	304,800.61
Connecticut	41° 12'	41° 52'	72° 45'	40° 50'	304800.61	152400.30
Florida						
North	29° 35'	30° 45'	84° 30'	29° 00'	600000.00	0.00
Iowa						
North	42° 04'	43° 16'	93° 30'	41° 30'	1500000.00	1000000.00
South	40° 37'	41° 47'	93° 30'	40° 00'	500000.00	0.00
Kansas						
North	38° 43'	39° 47'	98° 00'	38° 20'	400000.00	0.00
South	37° 16'	38° 34'	98° 30'	36° 40'	400000.00	400000.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False East	False North
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (m)	N_0 (m)
Kentucky						
North	37° 58'	38° 58'	84° 15'	37° 30'	500,000.00	0.00
South	36° 44'	37° 56'	85° 45'	36° 20'	500,000.00	500,000.00
Louisiana						
North	31° 10'	32° 40'	92° 30'	30° 30'	1,00,0000.00	0.00
South	29° 18'	30° 42'	91° 20'	28° 30'	1,000,000.00	0.00
Offshore	26° 10'	27° 50'	91° 20'	25° 30'	1,000,000.00	0.00
Maryland	38° 18'	39° 27'	77° 00'	37° 40'	400,000.00	0.00
Massachusetts						
Mainland	41° 43'	42° 41'	71° 30'	41° 00'	200,000.00	750,000.00
Island	41° 17'	41° 29'	70° 30'	41° 00'	500,000.00	0.00
Michigan						
North	45° 29'	47° 05'	87° 00'	44° 47'	8,000,000.00	0.00
Central	44° 11'	45° 42'	84° 22'	43° 19'	6,000,000.00	0.00
South	42° 06'	43° 40'	84° 22'	41° 30'	4,000,000.00	0.00
Minnesota						
North	47° 02'	48° 38'	93° 06'	46° 30'	800,000.00	100000.00
Central	45° 37'	47° 03'	94° 15'	45° 00'	800,000.00	100,000.00
South	43° 47'	45° 13'	94° 00'	43° 00'	800,000.00	100,000.00
Montana	45° 00'	49° 00'	109° 30'	44° 15'	600,000.00	0.00
Nebraska	40° 00'	43° 00'	100° 00'	39° 50'	500,000.00	0.00
New York						
Long Island	40° 40'	41° 02'	74° 00'	40° 10'	300,000.00	0.00
North Carolina	34° 20'	36° 10'	79° 00'	33° 45'	609,601.22	0.00
North Dakota						
North	47° 26'	48° 44'	100° 30'	47° 00'	600,000.00	0.00
South	46° 11'	47° 29'	100° 30'	45° 40'	600,000.00	0.00
Ohio						
North	40° 26'	41° 42'	82° 30'	39° 40'	600,000.00	0.00
South	38° 44'	40° 02'	82° 30'	38° 00'	600,000.00	0.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		**Origin Longitude**	**Origin Latitude**	**False East**	**False North**
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (m)	N_0 (m)
Oklahoma						
North	35° 34'	36° 46'	98° 00'	35° 00'	600,000.00	0.00
South	33° 56'	35° 14'	98° 00'	33° 20'	600,000.00	0.00
Oregon						
North	44° 20'	46° 00'	120° 30'	43° 40'	2,500,000.00	0.00
South	42° 20'	44° 00'	120° 30'	41° 40'	1,500,000.00	0.00
Pennsylvania						
North	40° 53'	41° 57'	77° 45'	40° 10'	600,000.00	0.00
South	39° 56'	40° 58'	77° 45'	39° 20'	600,000.00	0.00
Puerto Rico and Virgin Islands						
1	18° 02'	18° 26'	66° 26'	17° 50'	200,000.00	200,000.00
2 (St. Croix)	18° 02'	18° 26'	66° 26'	17° 50'		
Samoa	–14° 16'	–14° 16'	170° 00'			
South Carolina	32° 30'	34° 50'	81° 00'	31° 50'	609,600.00	0.00
South Dakota						
North	44° 25'	45° 41'	100° 00'	43° 50'	600,000.00	0.00
South	42° 50'	44° 24'	100° 20'	42° 20'	600,000.00	0.00
Tennessee	35° 15'	36° 25'	86° 00'	34° 20'	600,000.00	0.00
Texas						
North	34° 39'	36° 11'	101° 30'	34° 00'	200,000.00	1,000,000.00
North central	32° 08'	33° 58'	98° 30'	31° 40'	600,000.00	2,000,000.00
Central	30° 07'	31° 53'	100° 20'	29° 40'	700,000.00	3,000,000.00
South central	28° 23'	30° 17'	99° 00'	27° 50'	600,000.00	4,000,000.00
South	26° 10'	27° 50'	98° 30'	25° 40'	300,000.00	5,000,000.00
Utah						
North	40° 43'	41° 47'	111° 30'	40° 20'	500,000.00	1,000,000.00
Central	39° 01'	40° 39'	111° 30'	38° 20'	500,000.00	2,000,000.00
South	37° 13'	38° 21'	111° 30'	36° 40'	500,000.00	3,000,000.00
Virginia						
North	38° 02'	39° 12'	78° 30'	37° 40'	3,500,000.00	2,000,000.00
South	36° 46'	37° 58'	78° 3'0	36° 20'	3,500,000.00	1,000,000.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False East	False North
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (m)	N_0 (m)
Washington						
North	47° 30'	48° 44'	120° 50'	47° 00'	500,000.00	0.00
South	45° 50'	47° 20'	120° 30'	45° 20'	500,000.00	0.00
West Virginia						
North	39° 00'	40° 15'	79° 30'	38° 30'	600,000.00	0.00
South	37° 29'	38° 53'	81° 00'	37° 00'	600,000.00	0.00
Wisconsin						
North	45° 34'	46° 46'	90° 00'	45° 10'	600,000.00	0.00
Central	44° 15'	45° 30'	90° 00'	43° 50'	600,000.00	0.00
South	42° 44'	44° 04'	90° 00'	42° 00'	600,000.00	0.00

State Plane Co-ordinate System (SPCS) 1927

Several US states used the Lambert Conformal Conic projection for SPCS 1927. The various parameters for each zone in the 1927 system are given in the table below. Use these parameters with the program, together with the Clarke 1866 ellipsoid in feet.

	Standard Parallels		Origin Longitude	Origin Latitude	False Easting	False Northing
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (ft.)	N_0 (ft.)
Alaska						
Zone 10	51° 50'	53° 50'	176° 00'	51° 00'	3000000.00	0.00
Arkansas						
North	34° 56'	36° 14'	92° 00'	34° 20'	2000000.00	0.00
South	33° 18'	34° 46'	92° 00'	32° 40'	2000000.00	0.00
California						
I	40° 00'	41° 40'	122° 00'	39° 20'	2000000.00	0.00
II	38° 20'	39° 50'	122° 00'	37° 40'	2000000.00	0.00
III	37° 04'	38° 26'	120° 30'	36° 30'	2000000.00	0.00
IV	36° 00'	37° 15'	119° 00'	35° 20'	2000000.00	0.00
V	34° 02'	35° 28'	118° 00'	33° 30'	2000000.00	0.00
VI	32° 47'	33° 53'	116° 15'	32° 10'	2000000.00	0.00
VII	33° 52'	34° 25''	118° 20'	34° 08'	4186692.58	4160926.74

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False Easting	False Northing
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (ft.)	N_0 (ft.)
Colorado						
North	39° 43'	40° 47'	105° 30'	39° 20'	2000000.00	0.00
Central	38° 27'	39° 45'	105° 30'	37° 50'	2000000.00	0.00
South	37° 14'	38° 26'	105° 30'	36° 40'	2000000.00	0.00
Connecticut	41° 12'	41° 52'	72° 45'	40° 50'	600000.00	0.00
Florida						
North	29° 35'	30° 45'	84° 30'	29° 00'	2000000.00	0.00
Iowa						
North	42° 04'	43° 16'	93° 30'	41° 30'	2000000.00	0.00
South	40° 37'	41° 47'	93° 30'	40° 00'	2000000.00	0.00
Kansas						
North	38° 43'	39° 47'	98° 00'	38° 20'	2000000.00	0.00
South	37° 16'	38° 34'	98° 30'	36° 40'	2000000.00	0.00
Kentucky						
North	37° 58'	38° 58'	84° 15'	37° 30'	2000000.00	0.00
South	36° 44'	37° 56'	85° 45'	36° 20'	2000000.00	0.00
Louisiana						
North	31° 10'	32° 40'	92° 30'	30° 40'	2000000.00	0.00
South	29° 18'	30° 42'	91° 20'	28° 40'	2000000.00	0.00
Offshore	26° 10'	27° 50'	91° 20'	25° 40'	2000000.00	0.00
Maryland	38° 18'	39° 27'	77° 00'	37° 50'	800000.00	0.00
Massachusetts						
Mainland	41° 43'	42° 41'	71° 30'	41° 00'	600000.00	0.00
Island	41° 17'	41° 29'	70° 30'	41° 00'	200000.00	0.00
Michigan (current)						
North	45° 29'	47° 05'	87° 00'	44° 47'	2000000.00	0.00
Central	44° 11'	45° 42'	84° 20'	43° 19'	2000000.00	0.00
South	42° 06'	43° 40'	84° 20'	41° 30'	2000000.00	0.00
Minnesota						
North	47° 02'	48° 38'	93° 06'	46° 30'	2000000.00	0.00
Central	45° 37'	47° 03'	94° 15'	45° 00'	2000000.00	0.00
South	43° 47'	45° 13'	94° 00'	43° 00'	2000000.00	0.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False Easting	False Northing
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (ft.)	N_0 (ft.)
Montana						
North	47° 51'	48° 43'	109° 30'	47° 00'	2000000.00	0.00
Central	46° 27'	47° 53'	109° 30'	45° 50'	2000000.00	0.00
South	44° 52'	46° 24'	109° 30'	44° 00'	2000000.00	0.00
Nebraska						
North	41° 51'	42° 49'	100° 00'	41° 20'	2000000.00	0.00
South	40° 17'	41° 43'	99° 30'	39° 40'	2000000.00	0.00
New York						
Long Island	40° 40'	41° 02'	74° 00'	40° 30'	2000000.00	100000.00
North Carolina	34° 20'	36° 10'	79° 00'	33° 45'	2000000.00	0.00
North Dakota						
North	47° 26'	48° 44'	100° 30'	47° 00'	2000000.00	0.00
South	46° 11'	47° 29'	100° 30'	45° 40'	2000000.00	0.00
Ohio						
North	40° 26'	41° 42'	82° 30'	39° 40'	2000000.00	0.00
South	38° 44'	40° 02'	82° 30'	38° 00'	2000000.00	0.00
Oklahoma						
North	35° 34'	36° 46'	98° 00'	35° 00'	2000000.00	0.00
South	33° 56'	35° 14'	98° 00'	33° 20'	2000000.00	0.00
Oregon						
North	44° 20'	46° 00'	120° 30'	43° 40'	2000000.00	0.00
South	42° 20'	44° 00'	120° 30'	41° 40'	2000000.00	0.00
Pennsylvania						
North	40° 53'	41° 57'	77° 45'	40° 10'	2000000.00	0.00
South	39° 56'	40° 58'	77° 45'	39° 20'	2000000.00	0.00
Puerto Rico and Virgin Islands						
1	18° 02'	18° 26'	66° 26'	17° 50'	500000.00	0.00
2 (St. Croix)	18° 02'	18° 26'	66° 26'	17° 50'	500000.00	100000.00
Samoa	-14° 16'	-14° 16'	170° 00'		500000.00	0.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

	Standard Parallels		Origin Longitude	Origin Latitude	False Easting	False Northing
	ϕ_1 South	ϕ_2 North	λ_0 West	ϕ_0 North	E_0 (ft.)	N_0 (ft.)
South Carolina						
North	33° 46'	34° 58'	81° 00'	33° 00'	2000000.00	0.00
South	32° 20'	33° 40'	81° 00'	31° 50'	2000000.00	0.00
South Dakota						
North	44° 25'	45° 41'	100° 00'	43° 50'	2000000.00	0.00
South	42° 50'	44° 24'	100° 20'	42° 20'	2000000.00	0.00
Tennessee	35° 15'	36° 25'	86° 00'	34° 40'	2000000.00	100000.00
Texas						
North	34° 39'	36° 11'	101° 30'	34° 00'	2000000.00	0.00
North central	32° 08'	33° 58'	97° 30'	31° 40'	2000000.00	0.00
Central	30° 07'	31° 53'	100° 20'	29° 40'	2000000.00	0.00
South central	28° 23'	30° 17'	99° 00'	27° 50'	2000000.00	0.00
South	26° 10'	27° 50'	98° 30'	25° 40'	2000000.00	0.00
Utah						
North	40° 43'	41° 47'	111° 30'	40° 20'	2000000.00	0.00
Central	39° 01'	40° 39'	111° 30'	38° 20'	2000000.00	0.00
South	37° 13'	38° 21	111° 30'	36° 40'	2000000.00	0.00
Virginia						
North	38° 02'	39° 12'	78° 30'	37° 40'	2000000.00	0.00
South	36° 46'	37° 58'	78° 30'	36° 20'	2000000.00	0.00
Washington						
North	47° 30'	48° 44'	120° 50'	47° 00'	2000000.00	0.00
South	45° 50'	47° 20'	120° 30'	45° 20'	2000000.00	0.00
West Virginia						
North	39° 00'	40° 15'	79° 30'	38° 30'	2000000.00	0.00
South	37° 29'	38° 53'	81° 00'	37° 00'	2000000.00	0.00
Wisconsin						
North	45° 34'	46° 46'	90° 00'	45° 10'	2000000.00	0.00
Central	44° 15'	45° 30'	90° 00'	43° 50'	2000000.00	0.00
South	42° 44'	44° 04'	90° 00'	42° 00'	2000000.00	0.00

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

Ellipsoids

There are a range of ellipsoids in common or former use. The table below has the a and e^2 values for a number of common (and less common) ellipsoids.

Ellipsoid	a Semi-major Axis	e^2 Eccentricity
GRS80–WGS94–NAD83	6378137 m	0.006 694 38
Clarke 1866 (NAD27)	6378206.4 m	0.006 768 66
Clarke 1866 (NAD27)	20925832.2 ft	0.006 768 66
ANS (Australian)	6378160 m	0.006 694 541 855
Airy 1830	6377563.4 m	0.006 670 54
Bessel 1841	6377397.16 m	0.006 674 372
Clarke 1880	6378249.15 m	0.006 803 511
Everest 1830	6377276.35 m	0.006 637 847
Fischer 1960 (Mercury)	6378166 m	0.006 693 422
Fischer 1968	6378150 m	0.006 693 422
Hough 1956	6378270 m	0.006 722 67
International	6378388 m	0.006 722 67
Krassovsky 1940	6378245 m	0.006 693 422
South American 1960	6378160 m	0.006 694 542
GRS 1967	6378160 m	0.006 694 605
GRS 1975	6378140 m	0.006 694 385
WGS 60	6378165 m	0.006 693 422
WGS 66	6378145 m	0.006 694 542
WGS 72	6378135 m	0.006 694 317 778
WGS 84	6378137 m	0.006 694 38

Localization

If it is intended to do most conversions in the one SPCS zone, then the parameters for that zone can be coded into the program. When such a program is run, the program will prompt for the values (which allows the user to work in a different zone, as needed), but will display and store the regular values for the chosen zone. These can also be changed by changing the program, if a series of points on a different zone are to be converted.

The code required to 'hardwire' zone-specific values into the program is given below, based on a specific zone. If we were going to use California Zone III in SPCS 1983, its parameters are:

ϕ_0 = 36° 30' λ_0 = –120° 30'   a = 6378137 m e^2 = 0.006 694 38

ϕ_1 = 37° 04' ϕ_2 = 38° 26' E_0 = 2,000,000.000 m N_0 = 500,000.000 m

Latitude/Longitude to Lambert Conformal Conic Co-ordinates

The resulting code would be as follows, with the rest of the code left out. Note that the angular values are entered in HP notation (DDD.MMSS), as the program converts everything for internal use later.

Line	Instruction	Display	User Instructions
N001	LBL N		
………	……………		
N011	CL x		
N012	STO F		
N013	STO L		
N014	36.3		ϕ_0 value of zone
N015	STO P		
N016	—120.30		λ_0 value of zone
N017	STO Q		
N018	37.04		ϕ_1 value of zone
N019	STO C		
N020	38.26		ϕ_2 value of zone
N021	STO D		
N022	2000000.0		E_0 value of zone
N023	STO G		
N024	500000.0		N_0 value of zone
N025	STO H		
N026	6378137		a value for ellipsoid (WGS84/NAD83)
N027	STO A		
N028	0.00669438		e^2 value for ellipsoid (WGS84/NAD83)
N029	STO E		
N030	CHECK–ENTER A		
N031	PSE		
N032	INPUT A		
	…………………		
	…………………		

This will change subsequent line numbers (they will be 6 greater than before), as well as the program length and checksum, but the program should otherwise be unaffected and should run correctly.

Use the values for your preferred zone, and everything should be fine.

Reference

SNYDER, J.P., 1987. *Map Projections—A Working Manual*. U.S. Geological Survey Professional Paper 1395. Washington: US Government Printing Office.

Revisions

November, 2009. Line N081 corrected.

July, 2010. Line N220 corrected.

October, 2011. Standard parallel value for Alaska corrected.