

# Shamir Secret Sharing Codex

revision alpha-4.6

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Additional materials and copies of this document can be found at:

<https://secretcodex32.com/docs/index.html>

<https://github.com/roconnor-blockstream/SSS32/>

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## Principal Tables

## Addition

	A	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	Q	9	S	Y	5	4	2	0	T	Z	X	W	U	A	7	D	K	P	3	N	M	E	L	J	H	V	G	F	8	R	6	C
C	9	Q	4	P	3	S	0	2	W	8	R	T	E	C	M	G	N	Y	5	K	7	U	6	H	J	F	D	V	Z	X	L	A
D	S	4	Q	5	Y	9	6	L	M	J	K	7	V	D	W	A	X	3	P	R	T	F	0	Z	8	U	C	E	H	N	2	G
E	Y	P	5	Q	S	3	W	1	0	X	Z	2	C	6	F	J	9	4	H	L	A	M	K	N	G	V	D	R	8	7	U	
F	5	3	Y	S	Q	P	7	M	L	K	J	6	G	F	2	E	Z	4	9	8	0	D	T	X	R	C	U	A	N	H	W	V
G	4	S	9	3	P	Q	L	6	7	H	N	M	F	G	T	C	R	5	Y	X	W	V	2	8	Z	E	A	U	J	K	0	D
H	2	0	6	W	7	L	Q	9	P	G	V	Y	K	H	5	8	U	T	M	E	3	N	4	C	A	X	Z	R	D	F	S	J
J	0	2	L	T	M	6	9	Q	Y	D	F	P	N	J	3	Z	E	W	7	U	5	K	S	A	C	R	8	X	G	V	4	H
K	T	W	M	0	L	7	P	Y	Q	F	D	9	H	K	4	X	A	2	6	C	S	J	5	E	U	8	R	Z	V	G	N	
L	Z	8	J	X	K	H	G	D	F	Q	Y	V	7	L	U	0	5	R	N	3	E	M	A	S	4	W	2	T	9	P	C	6
M	X	R	K	Z	J	N	V	F	D	Y	Q	G	6	M	C	T	S	8	H	4	A	L	E	5	3	2	W	0	P	9	U	7
N	W	T	7	2	6	M	Y	P	9	V	G	Q	J	N	S	R	C	0	L	A	4	H	3	U	E	Z	X	8	F	D	5	K
P	U	E	V	C	E	G	F	K	N	H	7	L	J	Q	P	Z	3	2	A	0	8	9	R	W	T	S	5	4	M	L	X	Y
Q	A	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
R	7	M	W	6	2	T	5	3	4	U	C	S	Z	R	Q	N	G	L	0	D	9	8	P	V	F	J	K	H	E	A	Y	X
S	D	G	A	F	E	C	8	Z	X	0	T	R	3	S	N	Q	M	V	U	7	K	5	J	L	6	P	9	Y	2	W	H	4
T	K	N	X	J	Z	R	U	E	A	5	S	C	2	T	G	M	Q	H	8	9	D	0	F	Y	P	6	7	L	3	4	V	W
U	P	Y	3	9	4	5	T	W	2	R	8	0	A	U	L	V	H	Q	S	J	6	C	7	N	K	D	F	G	X	Z	M	E
V	3	5	P	4	9	Y	M	7	6	N	H	L	D	V	0	U	8	S	Q	Z	2	G	W	R	X	A	E	C	K	J	T	F
W	N	K	R	H	8	X	E	U	C	3	A	0	W	D	7	9	J	Z	Q	2	V	P	Y	L	M	6	5	S	F	T		
X	M	7	T	L	0	W	3	5	S	E	A	4	8	X	9	K	D	6	2	G	Q	Z	Y	P	V	H	N	J	U	C	P	R
Y	E	U	F	A	D	V	N	K	J	M	L	H	9	Y	8	5	0	C	G	2	Z	Q	X	T	W	4	3	S	7	6	R	P
Z	L	6	0	M	T	2	4	S	A	E	3	R	Z	P	J	F	7	W	V	Y	X	Q	D	G	N	H	K	C	U	9	8	
0	H	J	Z	K	X	8	C	A	E	5	U	W	0	V	L	Y	N	K	P	F	T	D	Q	9	7	6	M	4	3	G	2	
2	H	J	Z	N	R	Z	A	C	U	3	E	T	0	F	L	P	N	R	P	Y	V	W	G	9	Q	M	L	7	S	5	D	0
3	V	F	U	G	C	E	X	R	8	W	2	Z	S	3	J	P	6	D	A	L	H	4	N	7	M	Q	Y	9	T	0	K	5
4	G	D	C	V	U	A	Z	8	R	2	W	X	5	4	K	9	7	F	E	M	N	3	H	6	L	Y	Q	P	0	T	J	S
5	F	V	E	D	A	U	R	X	Z	T	0	8	4	5	H	Y	L	G	C	6	J	S	K	M	7	9	P	Q	W	2	N	3
6	8	Z	H	R	N	J	D	G	V	9	P	F	M	6	E	2	3	X	K	5	U	7	C	4	S	T	0	W	Q	Y	A	L
7	R	X	N	8	H	K	F	V	G	P	9	D	L	7	A	W	4	Z	J	S	C	6	U	3	5	0	T	2	Y	Q	E	M
8	6	L	2	7	W	0	S	4	3	C	U	5	X	8	Y	H	V	M	T	F	P	R	9	G	D	K	J	N	A	E	Q	Z
9	C	A	G	U	V	D	J	H	N	6	7	K	Y	9	X	4	W	E	F	T	R	P	8	2	0	S	3	L	M	Z	Q	

## Translation

[illegible]

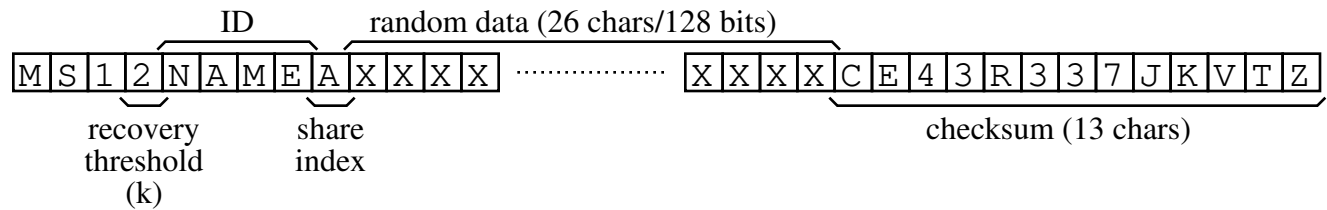
## Recovery

	A	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9	
A	×	#	Θ	Λ	†	Ω	¶	¥	◆	♣	Σ	ε	β	μ	Ξ	Φ	ρ	¢	Δ	†	♥	Θ	α	¤	η	Ψ	Γ	Π	Σ	%	€	
C	@	×	ε	Θ	¶	Ω	Σ	Λ	Φ	♦	♥	†	Π	¤	ε	Σ	α	Ψ	ρ	η	#	Ξ	¢	Δ	μ	¥	Θ	Γ	†	β	Ω	
D	Λ	¥	×	#	ρ	♦	α	♥	€	Θ	¢	Δ	Σ	Γ	¤	α	¶	Ω	ε	¶	Ξ	β	Ψ	μ	†	Θ	Π	Σ	η	†	Φ	€
E	Θ	Λ	€	×	α	Φ	¢	#	Ω	ε	Ψ	ρ	†	¢	Δ	Σ	†	Σ	ε	Π	Φ	¤	¶	Ξ	Γ	♥	†	μ	η	β	Σ	♦
F	†	Σ	Π	β	×	Θ	€	Ω	μ	η	†	#	ε	¢	♥	α	Λ	ε	¥	ρ	Φ	Σ	Ψ	α	Ω	¶	†	Δ	Ξ	Γ		
G	Ψ	¢	♥	Σ	¤	×	Δ	¶	Λ	¥	ρ	μ	♦	β	η	Θ	ε	Γ	Ω	α	†	Ξ	Π	†	Σ	Φ	€	Θ	#			
H	Σ	Φ	β	Σ	#	Γ	×	Ω	η	†	€	♥	Ξ	α	Σ	μ	¥	Θ	Ψ	Δ	♦	¶	Λ	¢	ρ	€	†	ε	¤	Θ	Π	
J	€	Θ	♦	€	¢	Σ	Ψ	×	Ω	¥	α	η	Ξ	ρ	β	¶	♥	†	Γ	Λ	Δ	Σ	ε	Θ	#	¤	μ	Π	†	Φ		
K	♥	Σ	¥	Ψ	Ξ	Θ	ε	¢	×	#	†	Θ	†	Γ	€	¤	ρ	μ	Φ	¶	Π	Δ	η	Σ	α	β	%	♦	€	Λ		
L	†	♥	Δ	Λ	¥	ε	€	†	Ψ	×	¶	Ξ	η	Θ	♦	Δ	α	¤	Σ	Γ	ρ	μ	†	¢	Π	β	Φ	Ω	Θ			
M	Φ	♦	Ω	€	♥	Π	#	€	†	Σ	×	Θ	ρ	¶	η	Ψ	Λ	¢	¤	α	Δ	Θ	ε	Ξ	μ	Γ	β					
N	η	†	Γ	Π	€	Ξ	♦	β	¤	μ	Φ	×	†	Ψ	#	Δ	Θ	Λ	α	Σ	¥	€	¢	%	Σ	¶	ρ	ε	Θ			
P	α	ρ	¶	†	η	♥	μ	ε	Ψ	¢	¤	†	×	Ω	Σ	¥	Π	Θ	β	Θ	Δ	Φ	Γ	€	Ξ	♦	€	Λ	#	Σ		
Q	Ξ	Θ	Δ	¤	Σ	%	α	β	μ	†	ε	Π	Ω	Ψ	×	€	¶	Φ	†	♦	♥	Γ	Θ	Σ	€	#	η	Λ	¥	Σ	¢	ρ
R	μ	η	Θ	Γ	♦	ε	Φ	Π	Δ	¤	Σ	€	¶	¥	×	ρ	€	%	Θ	¢	†	#	Ω	Λ	Ψ	β	♥	Σ	α	†	Ξ	
T	Σ	¶	Ψ	¢	Θ	Λ	ε	Ξ	#	♥	ε	Γ	€	Σ	Π	×	μ	Δ	η	†	†	Ψ	α	†	¢	Φ	ρ	α	€	Δ	¥	
U	Π	β	β	†	Θ	Λ	€	Σ	♥	Γ	Λ	€	Σ	Π	×	μ	#	†	†	†	Ψ	α	†	¢	Φ	ρ	α	€	Δ	¥		
V	%	Ω	Σ	Φ	¥	η	Λ	♦	Π	β	Θ	Λ	ρ	Σ	†	¢	Γ	♥	×	Σ	Ξ	€	α	#	¶	ε	Θ	ρ	Δ	μ	†	
W	Γ	Π	μ	η	€	Δ	Ω	†	Ξ	Θ	%	Θ	α	♥	Λ	ε	€	Φ	×	¶	β	¥	♦	#	Σ	Σ	Ψ	¢	†	ρ	¤	
X	†	ε	α	ρ	Π	Ψ	Γ	Δ	Σ	¶	Θ	β	Λ	♦	%	♥	†	μ	Σ	×	Ξ	Ω	η	Φ	€	¤	€	Θ	¤	¥	¢	
Y	♦	Θ	€	Ω	Σ	β	♥	Θ	Σ	Φ	#	¶	Γ	Δ	†	†	¢	¥	α	μ	×	ε	Ψ	ρ	¤	Λ	Ξ	Θ	η	Π	%	
Z	¤	μ	Ξ	Θ	Φ	†	Σ	Γ	ρ	Δ	†	♦	Σ	Λ	€	α	Ω	β	ε	Ψ	η	×	€	¥	Π	#	α	ρ	¢	¶	ε	
0	β	†	†	Σ	Λ	μ	ρ	Θ	Γ	Π	ε	¥	Δ	Λ	¶	Ψ	#	€	♥	ε	Σ	Ω	¢	×	Σ	†	♦	♥	€	Δ	μ	
2	Θ	Γ	¤	μ	ρ	%	η	ε	Ξ	β	€	¢	#	Ω	†	♦	Σ	Π	Λ	Φ	×	♥	†	¥	Ψ	¶	α	η				
3	ε	Ξ	ρ	Δ	β	¢	Π	¤	¶	†	Γ	%	¥	€	Ω	Σ	Σ	η	Φ	#	Θ	€	†	♦	×	μ	Θ	Λ	♥	Ψ	α	
4	Ω	€	Φ	♦	Ψ	†	¥	€	β	%	Λ	¢	μ	ε	α	Π	Σ	#	¶	Θ	ρ	♥	†	Ξ	×	Δ	¤	Γ	η	Σ		
5	Δ	¤	ε	Σ	¶	†	Θ	α	ρ	η	Φ	♥	Θ	♦	¢	%	Π	Ω	¥	μ	Θ	β	€	Λ	Γ	×	#	Ψ	Σ	†		
6	ρ	Δ	†	ε	†	Σ	η	Ξ	¢	α	μ	Σ	€	Φ	Ψ	β	Γ	%	Λ	¤	♦	Π	Θ	€	Θ	×	¥	♥	¶			
7	¶	†	¢	α	Γ	¥	η	Θ	ρ	♥	Σ	Ξ	Π	Θ	Φ	β	#	η	¤	†	€	ε	μ	Σ	♦	Δ	€	Θ	×	Λ	Ψ	
8	¢	α	Σ	¶	μ	#	¤	†	¥	Ψ	Δ	η	Θ	¢	†	Λ	Γ	Ξ	Π	€	ρ	Σ	Θ	β	Ω	ε	Φ	♦	Θ	×	♥	
9	¥	Ψ	#	♥	Δ	€	ρ	Σ	Θ	Λ	α	¤	Φ	Π	μ	€	Ξ	†	Θ	%	¢	η	ε	Γ	β	¶	†	Σ	Ω	×	♦	

## Fusion

	Χ	α	β	Γ	Δ	ε	η	Θ	Λ	μ	Ξ	Π	ρ	Σ	Φ	Ψ	Ω	@	#	%	¢	¥	€	¤	⊕	†	‡	§	¶	◆	♥			
Χ	Χ	α	β	Γ	Δ	ε	η	Θ	Λ	μ	Ξ	Π	ρ	Σ	Φ	Ψ	Ω	@	#	%	¢	¥	€	¤	⊕	†	‡	§	¶	◆	♥			
α	α	Γ	ε	Θ	μ	Π	Σ	Ψ	@	%	¥	¤	†	‡	§	◆	Λ	Ξ	ρ	Φ	Χ	β	Δ	η	⊕	†	‡	§	¶	♥	Ω	#	¢	€
β	β	ε	Δ	Π	Φ	μ	Λ	¤	†	◆	¶	%	€	@	Ω	†	♥	Σ	¢	¥	Ψ	#	Χ	α	η	Γ	ρ	Σ	Ξ	Θ				
Γ	Γ	Θ	Π	Ψ	%	¤	‡	Λ	ρ	Σ	Δ	€	¶	Ω	†	¢	α	ε	μ	‡	♥	Σ	€	Θ	Φ	η	‡	§	¶	Ω				
Δ	Δ	μ	Φ	%	Ω	‡	Σ	Γ	Ξ	Δ	¢	¶	Ψ	♥	†	α	η	Θ	ρ	¥	#	Σ	Θ	β	ε	Λ	Π	Ξ	Γ	η				
ε	ε	Π	¤	%	€	Θ	♥	¢	#	Χ	η	ρ	Ξ	†	¶	€	Ω	β	Δ	Φ	Λ	α	Γ	Σ	Θ	†	Σ	¥	Ψ					
η	η	Σ	Λ	Σ	†	@	¢	Ω	¥	♥	¤	ρ	μ	β	Γ	Ξ	Π	Δ	α	€	Ψ	⊕	†	¶	%	#	ε	Χ	Θ	Φ				
Θ	Θ	Ψ	¤	Λ	Χ	Θ	Ω	†	α	μ	†	#	Ξ	β	ρ	Δ	¶	¢	Γ	Π	%	Σ	♥	€	Φ	η	¥	◆	ε	Σ				
Λ	Λ	@	†	ρ	Γ	♥	¥	†	#	Θ	Χ	€	◆	Δ	Π	¶	%	Ψ	ε	Ψ	⊕	α	Ξ	η	Σ	¢	Σ	μ	β	¤	Ω			
μ	μ	%	◆	Ξ	¢	¥	α	Θ	Σ	β	Λ	€	¶	Γ	Σ	Ψ	†	Δ	Φ	Ω	†	ε	Π	⊕	β	η	ρ	#	⊕					
Ξ	Ξ	¥	¶	Δ	Σ	#	¤	μ	Χ	Σ	€	Φ	Γ	⊕	⊕	⊕	α	Λ	Ω	†	η	Π	⊕	¢	⊕	β	†	Ψ	ρ	ε				
Π	Π	¤	%	⊕	¢	Χ	ρ	†	ε	β	Φ	α	‡	¥	♥	#	η	Ξ	ε	μ	⊕	€	Γ	Θ	Σ	Ψ	¶	Δ	Λ					
ρ	ρ	†	ε	¶	Ψ	η	μ	#	Λ	Γ	Σ	β	%	⊕	Φ	α	¤	⊕	Θ	Δ	Σ	Ω	ε	Ξ	Π	†	¥							
Σ	Σ	Σ	€	Ω	♥	ρ	β	Ξ	Δ	€	⊕	†	%	ε	Θ	¥	¤	μ	Γ	η	Λ	†	¢	¶	#	Χ	Φ	Π	α	Ψ	◆			
Φ	Φ	◆	⊕	¢	†	Ξ	Γ	β	Π	¶	¶	Ω	¥	⊕	⊕	η	ε	Λ	¤	#	Σ	ρ	α	Δ	μ	†	%	Ψ	♥	Σ	Χ			
Ψ	Ψ	Λ	Θ	ε	α	η	†	Ξ	ρ	¶	Γ	¶	¶	¶	¶	¥	ε	†	μ	β	⊕	¤	Ξ	ε	η	⊕	¢	Γ	Δ	¢	Π	Σ		
Ω	Ω	@	†	¥	η	Π	Δ	Σ	¶	Ω	♥	¶	¶	¶	¶	α	ε	†	μ	†	Χ	Ψ	ρ	ε	€	⊕	Γ	¢	⊕	⊕	⊕	⊕	⊕	
@	@	ρ	♥	†	⊕	€	Δ	¶	Φ	Ψ	α	η	¢	μ	¤	#	Χ	◆	Π	Λ	†	Γ	¥	Σ	Σ	β	Ω	%	ε	⊕	⊕	⊕	⊕	
#	#	Φ	Σ	◆	ρ	Ω	α	¢	ε	†	Λ	Ξ	¤	Γ	ε	β	Ψ	Π	♥	¶	Σ	⊕	Χ	¥	Δ	⊕	⊕	⊕	†	η	%			
%	%	Χ	¢	α	¥	β	€	Γ	Ψ	Δ	Ω	€	@	η	#	Θ	Σ	Λ	¶	◆	Ξ	♥	Π	¤	ρ	⊕	Σ	†	Φ	†				
¢	¢	β	¥	ε	#	Δ	Ψ	Π	⊕	⊕	†	μ	♥	Λ	Σ	¤	ρ	†	Σ	⊕	Ξ	¶	Ω	%	Χ	€	@	η	Ω	Γ				
¥	¥	Δ	η	μ	Σ	Φ	⊕	α	Ω	η	⊕	⊕	†	ρ	Ξ	€	Γ	ε	⊕	Σ	¤	¢	β	Ψ	ε	♥	Λ	†	Π					
€	€	η	Ψ	Σ	Θ	Λ	◆	Σ	Ξ	†	Π	€	Δ	α	Ω	ε	¥	Σ	♥	Θ	¤	ρ	†	μ	Λ	β	Ξ	Γ						
¤	¤	⊕	Σ	†	β	α	†	♥	η	ε	‡	Γ	Σ	Δ	€	Δ	€	Φ	Σ	¥	Π	%	¢	ρ	⊕	Ψ	Ω	Λ	#	Σ	μ	⊕		
⊕	⊕	†	α	♥	ε	Γ	¶	ε	Σ	Π	¢	@	Ω	#	μ	η	◆	Σ	Δ	¤	Χ	β	†	Ψ	Λ	Ξ	⊕	Φ	¥	%	ρ			
†	†	¶	η	#	Λ	Σ	%	Φ	¢	@	Σ	ε	Χ	†	◆	Γ	β	⊕	ρ	€	Ψ	μ	Ω	Ξ	Π	¥	α	¤	♥	Δ				
‡	‡	♥	Γ	€	Π	@	#	η	Σ	¤	β	Ψ	Φ	%	Σ	¢	⊕	⊕	⊕	α	ε	¶	Λ	@	¥	ρ	◆	Δ	Χ	†				
§	§	Ω	ρ	Ξ	€	†	ε	¥	μ	η	†	¶	Π	Ψ	⊕	⊕	⊕	⊕	⊕	⊕	@	♥	β	#	Φ	α	◆	ρ	Γ	Λ	¢			
¶	¶	Σ	¶	Σ	Φ	€	Σ	Χ	Δ	β	ρ	Ψ	Ω	Π	α	♥	¢	@	ε	†	†	η	Λ	ε	¥	α	Δ	Γ	Θ	ε	μ			
◆	◆	¢	Δ	β	¶	¥	⊕	ε	¤	#	ρ	Δ	†	Ψ	Σ	Π	@	⊕	η	Φ	†	Γ	μ	%	♥	Σ	Λ	€	Σ	α				
♥	♥	€	Θ	η	¤	α	Ψ	Φ	Σ	Ω	⊕	ε	Λ	¥	◆	Χ	Σ	β	Ξ	%	†	Γ	Π	@	ρ	Δ	†	¢	μ	α	¶			

## Share Data Format



## Bech32 to Binary Conversion

A: 11101	K: 10110	T: 01011	2: 01010
C: 11000	L: 11111	U: 11100	3: 10001
D: 01101	M: 11011	V: 01100	4: 10101
E: 11001	N: 10011	W: 01110	5: 10100
F: 01001	P: 00001	X: 00110	6: 11010
G: 01000	Q: 00000	Y: 00100	7: 11110
H: 10111	R: 00011	Z: 00010	8: 00111
J: 10010	S: 10000	0: 01111	9: 00101

## Binary to Bech32 Conversion

00000: Q	01000: G	10000: S	11000: C
00001: P	01001: F	10001: 3	11001: E
00010: Z	01010: 2	10010: J	11010: 6
00011: R	01011: T	10011: N	11011: M
00100: Y	01100: V	10100: 5	11100: U
00101: 9	01101: D	10101: 4	11101: A
00110: X	01110: W	10110: K	11110: 7
00111: 8	01111: 0	10111: H	11111: L

## Symbols

ℵ Aleph	α Alpha	β Beta	Γ Gamma
Δ Delta	ε Epsilon	η Eta	Θ Theta
Λ Lambda	μ Mu	Ξ Xi	Π Pi
ρ Rho	Σ Sigma	Φ Phi	Ψ Psi
Ω Omega	@ At	# Hash	% Percent
¢ Cent	¥ Yen	€ Euro	⌘ Scarab
⊕ Earth	† Dagger	‡ Double-dagger	§ Section
¶ Paragraph	♦ Diamond	♥ Heart	



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# Part I: High-Level Introduction



ryptography is the art of hiding information. In particular, **Shamir Secret Sharing Scheme (SSSS)** is used to hide secrets in a distributed way. **codex32** describes a way for users, assisted by paper computers in the form of slide charts and circular slide rules (i.e., volvelles), to perform checksums and SSSS on Bitcoin secrets. If you are ready to begin using this process, jump to page 7 to follow the cheatsheet. For a more in-depth primer, continue reading the high-level introduction below.

## I.1. Shamir Secret Sharing Scheme



he **Shamir Secret Sharing Scheme (SSSS)** splits a **secret**  $s$  into  $n$  **shares**, any  $k$  of which can be used to reconstruct the original secret. Shares can be kept in separate places. The shares can later be used to reconstruct the original secret. It is important to emphasize that SSSS is a mechanism for storing backups, not a mechanism for enforcing a signing policy, as is done with multisig.

[illustration of SSSS vs multisig]

With SSSS,  $n$  is typically five or more, depending on your desire for redundancy, while  $k$  is two or three, reflecting your fear of individual shares being compromised. There is an inherent trade-off between the availability of a secret and its risk of theft. If you make many copies of your seed words, one of them may fall into the wrong hands. However, if you make too few, they could become lost, destroyed, or misplaced. The consequence in either case is a complete and total loss of funds. By using shares rather than complete copies of our seed, we can make this tradeoff in a more flexible way.

Shamir Secret Sharing Scheme was first proposed in the 1970s, and has historically required the use of computers to generate secrets and shares. Instead, this codex outlines a novel method of secret sharing that can be done entirely on paper.



## I.2. codex32



Using this codex illustrates a method for Shamir Secret Sharing Bitcoin secrets. This document also defines an error-correcting code and complete scheme for generating, checksumming, splitting, and reconstructing secret data.

The function of this codex is to provide a paper-based means to:

- Securely generate random data from potentially biased dice rolls or coin flips to create shares.
- Split a secret into up to 31 shares, of which some number of them are needed to reconstruct the secret.
- Recombine your shares into your original secret.
- Compute and verify powerful checksums as part of each share.

This scheme does not support passphrases or key hardening, so security rests solely on the strength of your randomness. Because of this, it is extremely important to generate truly random numbers. This document provides a dice de-biasing worksheet to generate random values from dice rolls by hand. If you prefer the added security of passphrase-based key hardening, you should instead use SLIP39. SLIP39 is a non-paper-based Shamir Secret Sharing Scheme for Bitcoin secrets. Which does, however, require the use of electronic computers.

## I.3. Computers and Trust

It is impossible to sign a Bitcoin transaction without giving an electronic computer access to secret key data, which puts the user in an unfortunate position. If misused or badly generated, private key data can be used to steal all of your coins. To make matters worse, there is no way to know how exactly an electronic computer is interacting with your keys.

General-purpose computers are so complex and exposed to an adversarial environment (i.e., in the form of Internet connections, arbitrary programs, and human beings). The standard advice is to never expose your key material to such machines. Instead, you should provide your keys only to hardware wallets, which interact with general-purpose computers narrowly, through an interface that does not expose your secret key data. But this introduces additional questions: how can the hardware wallet be sure that it's communicating with the correct user, and under correct circumstances? *Ultimately, there is no hardware wallet that a wizard can fully trust.*

Even hardware wallets are opaque and imperfect:

- If tasked with generating random data, it may do so insecurely.
- It may have bugs that cause key leakage, either now or as a consequence of some future software update.
- Key material stored in physical form can be extracted by an attacker with physical access, even if the wallet has "deleted" it.
- It may expose secret data through side channels, such as the electromagnetic waves emitted by processor activity, or by the varying power draw from a USB hub.

These risks have varying degrees of plausibility, but for a Bitcoin secret, which may exceed any one person's lifetime, even "trivial" risks add up to become very serious.

The good news is that unlike electronic computers, paper cannot remember or leak secrets! When handled correctly and disposed of securely, and this can be done without special skills, equipment, or magic.

Some limitations of SSSS include:

- SSSS requires that the complete secret be reconstructed in a single place before it can be used. If the shares created were initially distributed among different individuals in a group, the party that brings together the shares to recreate the secret has the opportunity to spend funds, even if their single-party authority was not intended.
- SSSS requires the generation of additional random data beyond the original secret, which must be generated securely.
- If any share is corrupted, the reconstructed secret will be wrong, and it's impossible to determine which share was responsible, or how many.

We have addressed the latter issue through the clever use of error-correcting codes, inspired by SLIP39. However, not much can be done about the fact that SSSS involves a single point of failure at the time that the secret key material is used. This is why this scheme is only to be used for backups, and not for enforcing a signing policy.

## I.4. Checksumming and Error Correction



When you copy or transfer keys, and especially when you are conducting hand computations, it is possible that errors may arise. A **checksum** is a technique used to determine the authenticity of received data, to detect whether there was an error in transmission, storage, or copying. Errors might also crop up during long-term storage (e.g., if a paper backup suffers water damage, or a cryptosteels' tiles are damaged making some of the letters illegible).

[illustration of SSSS vs multisig]

This scheme does not support BIP39 mnemonic codes, which is currently the most popular way of storing private key backups. Users should note that the BIP39 checksum is less than one word long, and may fail to detect even a single incorrect word. Its primary effects are to cause your key data to be an awkward length, and to prevent you from verifying your data's integrity by hand.

In contrast, the SLIP39 Shamir Secret Sharing Scheme can detect up to three errors and correct up to one error 100% of the time. Additionally, it will fail to detect other random errors with extremely low probability. However, the SLIP39 checksum is also quite difficult to compute or verify by hand.

In the Codex32 book, we introduce the **codex32** checksum, which can detect up to eight errors and correct up to four. codex32 has an even higher probability than SLIP39 of successfully detecting random errors. And most importantly, codex32 checksums can be computed and verified entirely by hand.

## I.5. Seeds and Seed Words

**B**IP32 is a protocol for deriving an effectively unlimited number of addresses from a single **master seed**, which may be between 128 and 512 bits long. Many users interact with BIP32 master seeds indirectly, (e.g., by storing a set of 12 or 24 BIP39 seed words). Unfortunately, these seed words correspond to a 512-bit secret, while codex32 works best with 128-bit secrets. It is recommended that users of codex32 generate a fresh 128-bit seed, using the instructions in this book, and sweep their coins to addresses derived from the new seed.

## I.6. Bech32 and Alternative Alphabets

**C**odex32 inherits its name from the Bech32 alphabet. In order to store 128-bit secrets, we re-use the Bech32 alphabet, which consists of the 10 Arabic numerals and 22 of the 26 letters of the Latin alphabet. The excluded letters are B, which may be confused with 8; O, which may be confused with 0; and I and 1, which may be confused with many things, such as each other.

Parts of the codex32 process use an alternate alphabet, consisting mostly of Greek letters. This alphabet is used for intermediate computations, but never for data storage, and nothing represented in it is ever secret data. A table of pronunciation is provided on the Reference page at the beginning of this document.

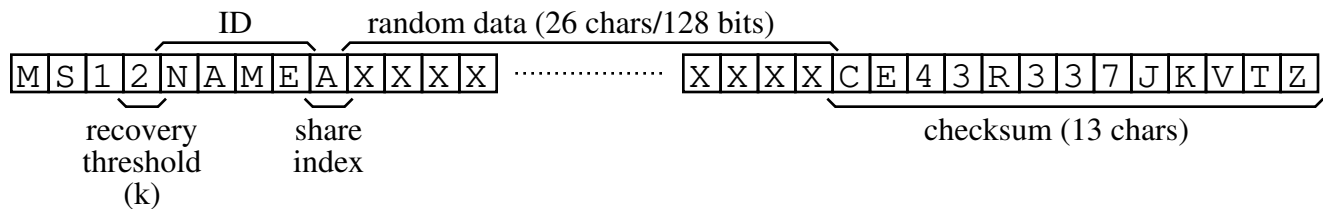
The remainder of this document provides detailed mechanical instructions. If you are interested in learning the mathematical theory behind this all, users are encouraged to check out the mathematical companion or contact Pearlwort at [pearlwort@secretcodex32.com](mailto:pearlwort@secretcodex32.com).

# Part II: codex32 Components

## II.1. Share Data



or a 128-bit secret seed, each share is 48 characters long. Shares begin with the three-character prefix MS1. This is followed by a six-character **header**. The next 26 characters are the data portion. The final 13 characters are the checksum.



The header consists of:

- The **threshold**, which is the value  $k$ , a digit between two and nine inclusive, although the main document only supports  $k$  values two and three. When secret splitting is not used, a zero digit is placed here instead.
- The **identifier**, which is four bech32 characters.
- The **share index**, which is any bech32 character except for  $S$ . The  $S$  index is the **secret index**. The data portion of the secret index contains the secret seed.

Shares of one secret all have the same threshold and identifiers. If you have multiple secrets, you should use distinct identifiers for each to avoid mixing up shares of different secrets with each other. The identifiers are not considered secret themselves.

If the user merely wants to checksum their secret and not use secret splitting, they should use the same format, but with the digit 0 for the threshold value and S for the share index.

## II.2. Paper Computers & Volvelles



and computation for the procedures in this document can be performed either by using the volvelle wheels or principal tables (at the front of this document) to look up values. Although the volvelle wheels take time to cut out and assemble, they are generally easier to use than the tables, when available.

There are three volvelles in this codex. Each serves a different function, and has slightly different usage instructions.

**1. Addition.** To add two characters, turn the addition wheel to one of them and look through the window corresponding to the other. It does not matter which character is which; addition is symmetric.

**2. Translation & Fusion.** A common task in the scheme is to "translate" share data by a given recovery symbol. To do so, turn the translation/fusion wheel so that the window on the fusion side is showing the correct symbol. Then, turn the wheel over; the translation side will act like a decoder ring, mapping characters to characters.

Sometimes you will need to translate a share by multiple symbols at once. To accomplish this, turn the fusion wheel to the first symbol. Find the next symbol on the inner wheel; whatever symbol that it's pointing to, turn the fusion wheel to that symbol. Repeat for all of the symbols that you need to combine. The fusion wheel will wind up at the final product. You can now turn the wheel over to translate by this symbol. As with addition, the order in which you take your original symbols does not matter.

**3. Recovery.** When recovering a secret, you will need to look up "recovery symbols" that will be used. To do this with the recovery wheel, turn the wheel to the share you want to translate. Mark down the symbols pointed to by the *other shares* indices and fuse these together.

*Important:* Unlike the other wheels, the recovery wheel can easily be used in the wrong order. Be careful!

# Part III: Process Instructions / Cheatsheet

## 1. Volve Assembly

You will need: a craft knife, scissors, card stock, brass fasteners, and the volvelle printouts from Module 0.

1. Cut out each disc with scissors. Then, cut out the windows on the top discs with the craft knife.
2. Cut out the small center circle in each bottom disc. Cut a slit along one of the small lines of the cross in each top disc.
3. Attach the discs with a brass fastener through the center holes.

## 2. Create New Seed (Initial $k$ Shares)

You will need: the addition volvelle, dice de-biasing worksheet, checksum worksheet, pencil, eraser, and your secret seed. For each of your initial  $k$  shares, you should:

1. Generate random data by rolling dice, following the instructions on the dice de-biasing worksheet.
2. Follow the instructions on the checksum worksheet to affix a checksum.

## 3. Create New Seed (Additional/Derived Shares)

You will need: the addition volvelle, fusion/translation wheel, translation worksheet, and pencil.

1. Translate the initial shares using the symbols in the derived shares section.
2. Add the translated initial shares to get the new derived share.

## 4. Recover Secret

You will need: the recovery wheel, and everything used for derived share creation (see above). To recover your secret, you must have  $k$  shares available.

1. Look up their recovery symbols with the recovery wheel.
2. Fuse all of the symbols for each share with the fusion wheel to get a symbol for each share.
3. Translate the share by that symbol.
4. Add all of the translated shares to get your secret.

## 5. Verify Shares

You will need: the addition volvelle, checksum worksheet, pencil, eraser, and the share to validate.

1. Copy the share data into the bold boxes of the checksum worksheet.
2. Follow the instructions to complete the worksheet, checking that the final result is SECRETSHARE32.

## 6. Correct Shares

You will need: the addition volvelle, checksum worksheet, pencil, eraser, and the share to validate.

1. Follow the instructions above to verify your share.
2. If the result is not SECRETSHARE32, enter the result into the online tool. This data does not contain any information about your share data, only about the errors.
3. Add the given values to the given characters in your share, according to the online instructions.

## X. Deriving Addresses and Spending Coins

It is an open question as to how to derive addresses or spend coins using paper computers. Please contact Pearlwort at [pearlwort@secretcodex32.com](mailto:pearlwort@secretcodex32.com) if you believe you have insight into this.

## III.1 Generate a New Secret

We generate new secrets indirectly by generating our  $n$  shares, which will imply the final secret. The process for generating a new secret seed is as follows:

1. Choose a threshold  $k$  and total number of shares  $n$  that suits your needs. The threshold  $k$  should be two or three, and  $n$  must be 31 or less. For  $k > 3$  see Module 2, but this is not recommended.
2. Choose a four-character identifier for your new secret seed. The identifier can be anything (e.g., a name or nym), as long as it only uses the Bech32 character set. The identifier itself is not secret. However, the identifier should be unique for each secret seed.
3. Follow Section III.1.A to generate the first  $k$  shares.
4. Follow Section III.1.B to generate the remaining  $(n - k)$ .
5. Copy and distribute your  $n$  shares into safe and secure locations. Additionally, remember that you will need to recover at least  $k$  of these shares to recover your secret seed. Also remember that anyone else who recovers  $k$  of these shares can also recover your secret seed and control your coins.
6. Securely dispose of all worksheets that you used in the generation procedure. If these worksheets are not securely disposed of, they could be used to recover your secret seed.
7. (Optional) Load your shares into your codex32-compliant wallet or use the Recover Secret procedure in Section III.2 to compute addresses or access your coins.

### III.1.A Create First Share

You will need:  $2k$  copies of the checksum worksheet and the dice de-biasing worksheet.

1. Fill out the header portion of the  $k$  checksum worksheets with your chosen threshold  $k$  and chosen identifier.
2. Place a unique share index on each worksheet starting with share A on the first worksheet, C on the second worksheet, and so on through  $k$  characters from the Bech32 characters. Recall that the B and I are not valid characters.
3. Using the dice de-biasing worksheet, generate 26 random characters and write them in the **bold squares** of the checksum worksheet.
4. Once all of the random data is generated, use the rest of the checksum worksheet to generate a checksum for each share.
5. **Critical Step:** Verify your checksum by copying each of the 48 characters of the share into a fresh checksum worksheet. Follow the checksum verification instructions to verify each checksum. If any checksum fails to verify, make more copies of the checksum worksheet and redo the checksum generation and checksum verification steps. Failure to verify each checksum may lead to irrecoverable loss of the secret seed and funds.

*Special rules for  $k = 1$ .* If you are not splitting your secret, use a 0 digit in the threshold place, and use the S character in the share index place. Follow the same instructions for generating the data portion and the checksum.

*Special rules for pre-existing secrets.* If you have a pre-existing seed, include this as an initial share, using S for its share index. When deriving additional shares, use the alternate table in Module 2 rather than the table in the following section. This process is not recommended, but may be useful in some scenarios such as re-sharing an existing secret.

## III.1.B Create Derived Shares

You will need:  $(n - k)$  checksum worksheets, and the translation worksheet for your value of  $k$ .

The remaining  $(n - k)$  shares are derived from the first  $k$  shares, using the translation worksheet. For each derived share, use the following process to derive it:

1. Make a copy of the translation worksheet for the value of  $k$  that you are using and label the shares with the share indices from the shares that you have already generated (e.g., A, C, and D, if  $k = 3$ ).
2. Label the final share index with the new share index that you want to derive. This can be any bech32 character, but most likely you will just want to use the next available character.
3. In the derivation table (below) for your value of  $k$ , find the column corresponding to the new share index. Copy the symbols from that column into the translation worksheet, next to the share index for each row. There is an illustration on Page 18 if this is unclear.

<b>k = 2</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>A</b>	Π	Θ	Δ	ρ	β	α	Ξ	Ω	α	μ	€	♥	η	@	ç	Λ	Γ	%	ε	¥	Φ	Σ	¶	‡	#	†	Ψ	Θ	Σ	♦
<b>C</b>	ρ	Λ	Γ	Π	α	β	μ	Ψ	Θ	Ξ	¥	♦	ε	#	%	Θ	Δ	ç	η	€	Σ	¶	Σ	†	@	†	Ω	α	Φ	♥

<b>k = 3</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>A</b>	μ	Ξ	✂	Θ	α	#	¥	¶	@	Γ	Σ	#	Φ	Σ	Ξ	μ	¶	@	Δ	Θ	€	¥	Δ	Σ	Γ	€	Σ	α	Φ
<b>C</b>	η	η	✂	¥	€	Ψ	Δ	α	Ω	%	@	Ω	@	α	ε	ε	β	Ψ	ç	€	Δ	Γ	%	#	ç	Γ	β	¥	#
<b>D</b>	Π	ρ	✂	Σ	Σ	α	@	♦	α	Ω	¶	β	Σ	♥	Π	ρ	♥	β	Ω	Φ	#	#	Ψ	Σ	Ψ	@	♦	Φ	¶

4. Follow the translation worksheet instructions to derive the new share.

Derivation tables for  $k$  from four up to eight can be found in Module 2. However, we discourage the use of large  $k$  values, which are difficult to use and increase the chance of key loss.

## III.2 Recover a Secret

You will need:  $k$  checksum worksheets, and the translation worksheet for your value of  $k$ .

Normally, you would not recover a secret seed yourself. Instead, you would load shares into a codex32-compliant wallet. However, you can recover the secret seed by hand if no compatible wallets are available or you feel a need to demonstrate your conjuring ability. The recovery procedure uses exactly  $k$  shares. If you have more than  $k$  shares, you can select any  $k$  of them and set the other shares aside.

Use the following procedure to recover the share:

1. For each share, fill in a checksum worksheet and verify the checksum. If a checksum fails to verify, you may have made an error on your worksheet, or there may be an error in your shared data. If there is an error in your share data, you can try substituting the share with a different one. Otherwise, you will need to perform the error correction procedure on your share, which will involve the assistance of an electronic computer.
2. Label the translation worksheet as though you were deriving a new share. Use your existing shares' indices as the "initial shares" and S as the "new share" index.
3. Rather than using a derivation table, fill in the symbols for each share on the translation worksheet using one of the following procedures:



## III.2.A Recovery by Table Lookup

If your volvelles are missing or otherwise inconvenient to access, you can do the entire process using the Principal Tables located at the front of this booklet, or available online at [secretcodex32.com](http://secretcodex32.com).

$k = 2$ . For each share, find that share's **column** in the recovery table and find the symbol on the **row** of the other share. Copy this symbol into the translation worksheet.

$k > 2$ . For each share, find that share's **column** in the recovery table and find all of the symbols in the **rows** of the other shares. Fuse these symbols together pairwise using the fusion table until you have only one left. Copy this into the translation worksheet.

Notice that the fusion table is symmetric, so it does not matter if you swap rows and columns. The recovery table is **not** symmetric, so you must use this table in the correct order.

Once you have copied everything into the translation worksheet, follow the Translation Worksheet Instructions page as though you were deriving a new share. Rather than using the addition wheel, you can use the addition table. The result should be a share with index  $S$ , which is your recovered secret.

## III.2.B Recovery by Volvelle

Using the volvelles is easier and less error-prone than using the tables. If you have your volvelles, the recovery process is as follows.

$k = 2$ . For each share, turn the recovery wheel to **that share's index**. Look up the symbol pointed to by the **other share's index** and copy that into the translation worksheet.

$k > 2$ . For each share, turn the recovery wheel to **that share's index**. Look up the symbols pointed to by the other shares' indices. Fuse these symbols together using the fusion wheel:

1. Turn the wheel so that it is pointing to the first symbol.
2. Find the next symbol on the inner part of the wheel. This symbol will point to a new symbol. Turn the wheel so that it points to the new symbol.
3. Repeat the above step for all the remaining symbols to fuse. (If  $k = 3$ , then no repetition is needed.) The resulting symbol is your result. Copy this into the translation worksheet.

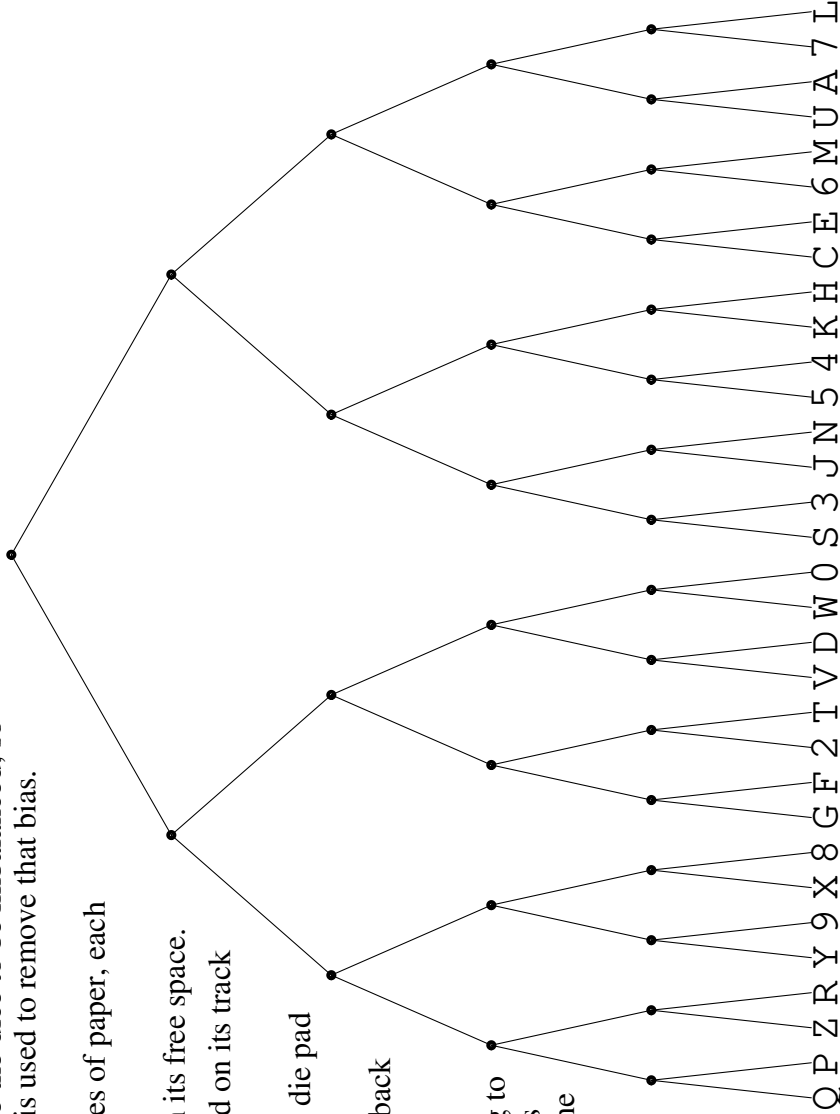
Once you have copied everything into the translation worksheet, follow the Translation Worksheet Instructions page as though you were deriving a new share. The result should be a share with index  $S$ , which is your recovered secret.

# Dice De-biasing Worksheet

Most dice have small manufacturing imperfections that cause the dice to be imbalanced, so some values appear more often than others. This worksheet is used to remove that bias.

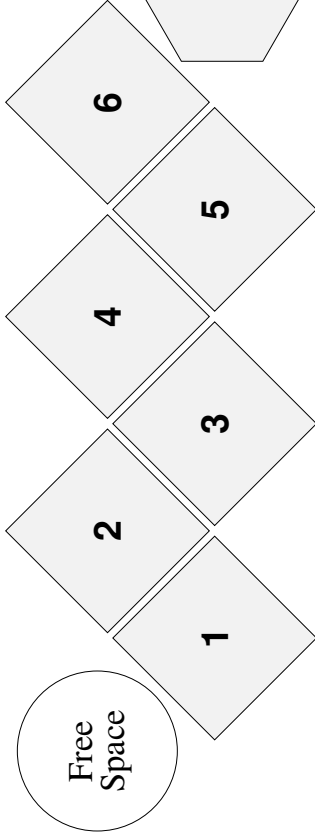
You will need: five distinct dice, five die markers (e.g., pieces of paper, each labeled by which die it corresponds to), and this worksheet.

1. Choose a die track for each die. Put the die's marker on its free space.
2. Roll all five dice. Move each die's marker to the die pad on its track indicating its value.
3. Re-roll the same five dice again and set each **die** on the die pad indicating their second values.
4. If a die showed the same value twice, move its marker back to the free space and repeat steps two and three.  
*You must redo both rolls!*
5. Using your finger, follow the tree to the right according to the die tracks. Take the first left branch if the first die is to the left of its marker, and the right branch if it is to the right. Similarly, take the second branch based on the results on the second die track, and so on, until the bottom of the tree, which has the resulting character.
6. Repeat steps one through five for each character.

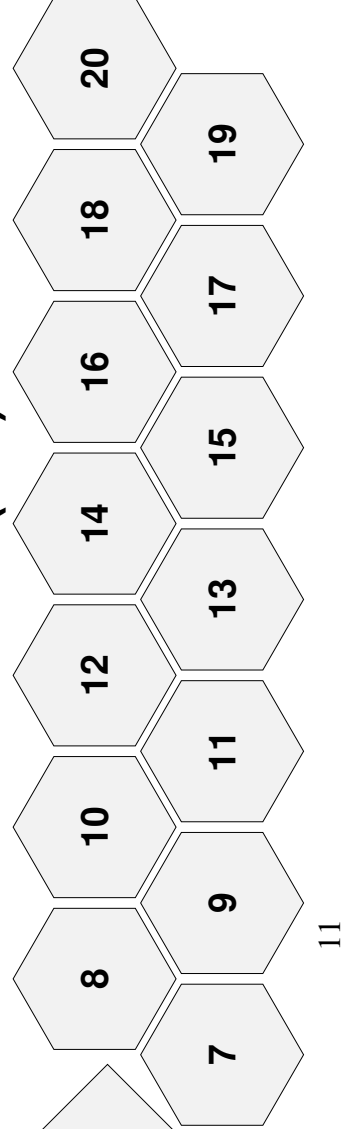


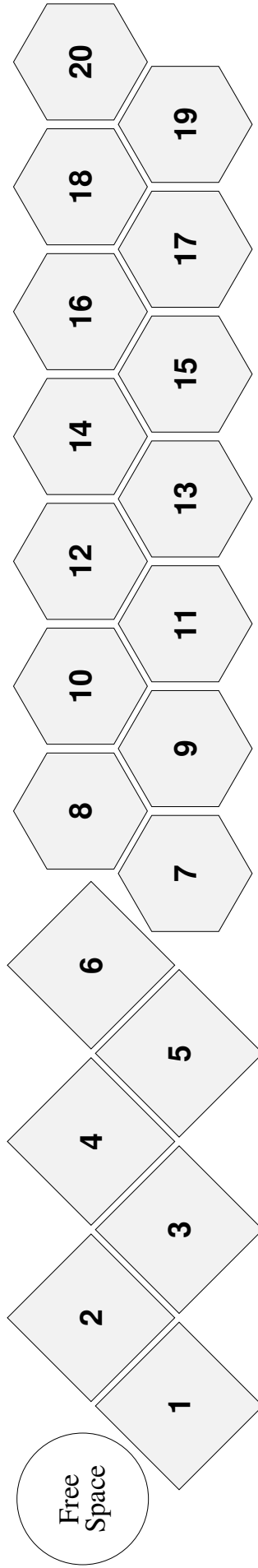
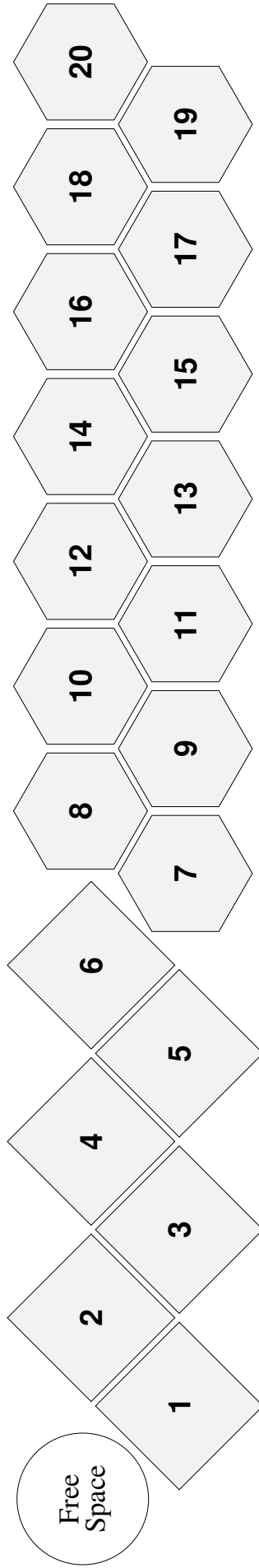
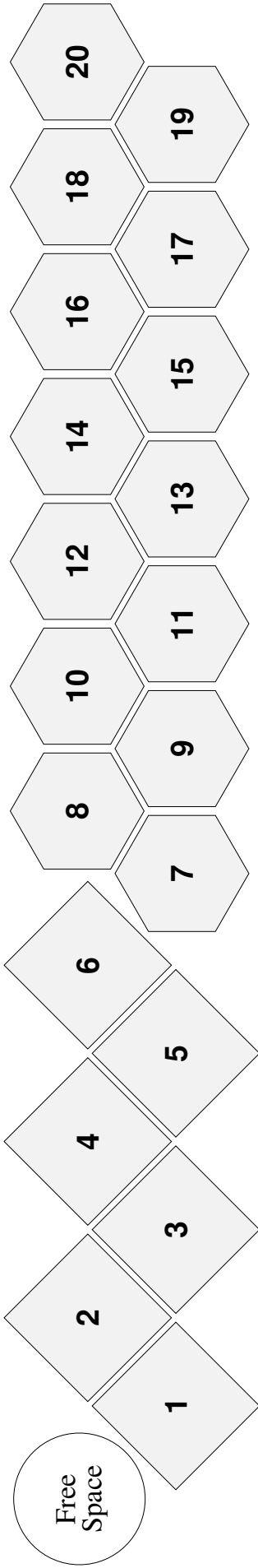
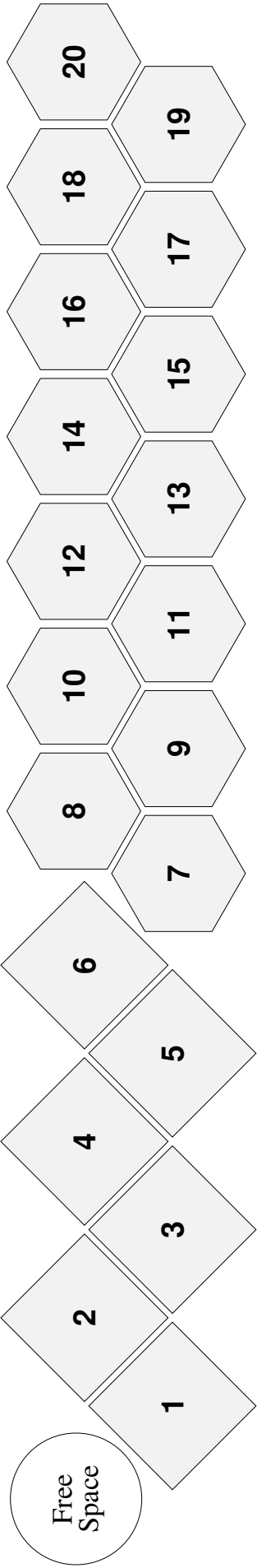
## Die Tracks

### Die Pads



### Die Pads (d7+)





# Checksum Worksheet (Generation Instructions)

The checksum worksheets are used to generate and verify checksums. These are the most frequently used and important worksheets of codex32.

You will need: a checksum worksheet, checksum table, and addition wheel.

### Generating a checksum:

1. Fill in the top diagonal squares (i.e., the bold ones) with your random data. You should have enough data to fill the non-pink bolded squares.
2. Add the first row to the second to fill in the third row, using the addition wheel.
3. Look up the two leftmost under hanging symbols from the third row in the checksum table (pages 11-12) to fill in the fourth row.
4. Repeat the above two steps, adding the third and fourth rows, looking up the fifth to fill in the sixth, and so on. With this approach, you will be able to complete the entire sheet except for the pink squares.
5. To complete the pink squares, work from the bottom up, adding each row to the one above it until all of the squares are filled. The completed share can now be read from the top diagonal, including the checksum (i.e., the pink bolded squares).

The figure shows a 3D visualization of a 5x5x5 cube, divided into three sections labeled 1, 2-4, and 5. The cube is composed of smaller cubes, each containing a number or a symbol. The numbers are arranged in a way that suggests a mathematical or logical puzzle. The symbols include letters, numbers, and mathematical operators like plus and equals signs.

The cube is divided into three sections:

- Section 1:** The front face of the cube, showing a 5x5 grid of numbers and symbols.
- Section 2-4:** The middle section, showing a 5x5 grid of numbers and symbols.
- Section 5:** The back face of the cube, showing a 5x5 grid of numbers and symbols.

The numbers are arranged in a way that suggests a mathematical or logical puzzle. The symbols include letters, numbers, and mathematical operators like plus and equals signs.

# Checksum Worksheet (Verification Instructions)

### Verifying a checksum:

1. Fill in the top diagonal with your share data; you should have enough to fill all of the bolded squares.
2. (Optional) Fill the bottom diagonal, if you have access to this data. It will help you catch mistakes.
3. Fill in the rest of the worksheet as you did when generating a checksum. If your final row does not match SECRETSHARE32, or if any of your computed bottom diagonal values don't match the expected values, there is a mistake in the worksheet or your data has been corrupted.

In case of error, first recompute every value in the bad column and check that you copied all of the share data correctly. Then, try redoing the worksheet entirely. If the checksum is consistently bad, your data is corrupt and you need to attempt the online recovery process.

The figure displays a large grid of 1000 cells, organized into three columns labeled 1, 2, and 3. The grid is filled with various numbers, letters, and symbols, arranged in a way that suggests a mathematical or logical puzzle. The cells are arranged in a grid that is 1000 cells wide and 1000 cells high. The grid is divided into three main sections, each corresponding to a column label. The first section (column 1) contains numbers and symbols, the second section (column 2) contains numbers and symbols, and the third section (column 3) contains numbers and symbols. The grid is filled with numbers, letters, and symbols, arranged in a way that suggests a mathematical or logical puzzle. The cells are arranged in a grid that is 1000 cells wide and 1000 cells high. The grid is divided into three main sections, each corresponding to a column label. The first section (column 1) contains numbers and symbols, the second section (column 2) contains numbers and symbols, and the third section (column 3) contains numbers and symbols. The grid is filled with numbers, letters, and symbols, arranged in a way that suggests a mathematical or logical puzzle.



MS32 Checksum Table

AA	STP2KRRLLRG5	CA	CYANSPPLRLTC0	DA	RJQM3EE7ZVTSL	EA	28TYF334FFFT0G	FA	E724WTT5GDT7R	GA	TAUZHMMZ78TFY	HA	Q4S3688WJ716T	JA	G6VGU99JW4TRS
AB	K8XTK99EMGRK	CB	7G6JS8890G6D	DB	97863LLC6QGJA	EB	VIV9FHHN39GD2	FB	LJD5WDDJSPGUP	GB	XHS6PPG2JGCF	HB	XBTUW99JW4TRS	KB	WKTFURR5KEGPJ
AC	H9T8KYYCXLXN	CD	L2H7SXXYRDZU4	DE	U9KJ3XXP9MS2D	EC	DFPFKKJ48UJN7	FC	7SQCVWU92FNU7	GC	8MGU6QQFWSU03	HC	8MGU6QQFWSU03	KB	WKTFURR5KEGPJ
AD	U0HRKUQOYLXN	CE	8NTGS77UC5S2A	DD	U9KJ3XXP9MS2D	ED	4SADFWM2W7SA6	FE	XFUW55N06SV3	GD	LZXC6CC34FSQ8	HD	LZXC6CC34FSQ8	KB	WKTFURR5KEGPJ
AE	GJAKMM8C39FU	CF	QAHSEEMY68S8	DE	MTUL3PPEX48CH	EF	J7HQFFEDJDS88Q	FF	P8K3WNNVN58KT	GF	NYQXRRR6978PV	HF	CVV46LLKF88JR	KB	WKTFURR5KEGPJ
AF	3FVXKZ7782LEV	CG	EXLSQZQZMLQH	DH	ZSDH3C4CLXWLG	EF	T9XGFFS5D2LHS	FF	CU8EW224V0LX8	GH	2L3WH66R69L3U	HF	PFAA66TITZTD70	KB	WKTFURR5KEGPJ
AG	UNOGK00N6DS9	CH	SUN3SD0XMDUT	DH	02WE344JM5D5M	EH	XL9XFAAES3DVT	FG	4XYHW88C34D68	GH	89JQH88H81DDQ	HH	Y7DN6TITZTD70	KB	WKTFURR5KEGPJ
AH	6LGFKEF42UW8J	CJ	J5S5STTF7HW7F	DJ	EXFC3NN5RCWKE	EJ	ONZ8FMMLGAWFW	FJ	N2RKWPP7FEMC9	GJ	4P4P33GJLW0Z	HJ	2PEJ6DDYN2WUD	KB	WKTFURR5KEGPJ
AI	957QKKK29T44Q	CK	D2E8S55KEQ4VM	DJ	K3L133VTVY04YT	EK	LY5WFYV0024MU	FK	VA4LW77FEMW42H	GK	77RGHWHCY4AS	HK	77RGHWHCY4AS	KB	WKTFURR5KEGPJ
AL	T26KCCY5HUGA	CL	RMKRS6CGUJ3X	DL	CDT132Z94NJEK	EL	3CQ5F22W7KJXP	FL	ZPP9WS0LJHJH2	GL	SZHHJQFECJQD	HL	MZMP60U49PJNZ	KB	WKTFURR5KEGPJ
AM	8RKN88MNQF60	CM	UV02S9980TFR5	DM	86AC2AA64JFYF	EM	WOKAF443EPF5N	FM	AKHVW005C9F9C	GM	4P4P33GJLW0Z	HM	Y4G6RR22KFP5	KB	WKTFURR5KEGPJ
AN	RYEPKSSVA8KHZ	CN	TT9CSJSPWKWE	DN	SACS322DURKXF	EN	EGNOF2Z3HXK7E	FN	23J7WCC3QKZG4	GN	CJYFHGG3QKGLJ	HN	N6G6655A3KVA	KB	WKTFURR5KEGPJ
AO	L4CUKVSKKCY3	CP	H6Y9SMMW2ACA	DP	VVED3K33HJC46	EP	9EJF7776UHC2D	FP	KONRWYMANCMX	GQ	AC5UDDH55ZQJ3	HP	0F866GP8OC1W	KB	WKTFURR5KEGPJ
AP	XWF5K444FFD05	CQ	W4D4SH444XQD6	DQ	4HG9300GGFQ92	EQ	UZR6F88RRVQ6A	FO	OMZTAAZ3GQTK	GQ	AC5UDDH55ZQJ3	HP	0F866GP8OC1W	KB	WKTFURR5KEGPJ
AQ	Y2VXKHHTPFDDC	CR	V904S444HAZP5R	DR	HJN343DD2QDPUN	ER	7XEF799PTGPRY	FR	DLCLNLLQ2VFPJ	GR	LJWUWH00KXUP9G	HS	37JZ6KKLY4H4Y	KB	WKTFURR5KEGPJ
AR	P0REKJ7JW4RHW	CS	F0LGS5ZJFGHHQ	DS	JEZG3GQ058HLS	ES	MFVHFQJL907WF	FS	64CAPWGHT7LZ	GS	6MT3K22VGHXT	HT	RN896YD7C7M2	KB	WKTFURR5KEGPJ
AT	NBK7KQOQU07Q4	CT	M2Z8SZZJF97EW	DT	Q5H0366AW2737	ET	PFUFJFJK907WF	FT	G6KTHCCPJP7G9	HS	RN896YD7C7M2	HT	RN896YD7C7M2	KB	WKTFURR5KEGPJ
AV	F5SZK66XUNN3Y	CU	PLVMSCC6QCNGI	DU	6F3N3Q08AHNQ0	EU	U06VFGVVKJNL	FU	Q9MAWJUDHKNWN	GU	XJD2HZZMPUNE5	HU	WEPE677HD9N2M	KB	WKTFURR5KEGPJ
AW	W760KAAPQAXI7	CV	X3XKSLLAUKYJ9	DV	A8M7388QPEY64	EV	5JSPF0012U9Y2	FV	8T3SW44Z1CY5F	GV	4G88H9904JIRW	HV	70156EES3IYSP	KB	WKTFURR5KEGPJ
AX	2X5DK33DE9206	CW	AMDXSYYXTFAMV	DW	XCWSW30UMKXAN	EW	ODM3F55SARAVT	FW	U56QWWM3U8AAQ	GW	WHVHH7782DA28	HW	91QY62ZT3X5AE	KB	WKTFURR5KEGPJ
AY	ELAK222KW6XN	CX	2FG5SNN39WZKP	DX	3L4U3TIVCPZ73	EX	C27RFR88NYZPX	FX	TNLJWEEJQZSD	HX	ESF9HF5Y2Z82	HY	J9K6644UGN259	KB	WKTFURR5KEGPJ
AZ	A3ZYKWWJ7JEBG	CZ	3KRYSGG2J3MLG	DY	207V3S5H07MHC	EY	R44NFCUUMXMG0	FY	SV5ZWZ2A9LMEY	IZ	F5W66W81VMWV	JY	JYJLJVMVR8MYH	KB	WKTFURR5KEGPJ
A0	V6QHKLLRGE9J8	CO	Y40WSAAL5J9TU	DZ	WGR43555NLKEVR	EZ	8AG2FUUC5NEN5	FZ	5YFMMXX4HEZL	HZ	DNL6222R0YEXH	JZ	9QXUGGLN0ELV	KB	WKTFURR5KEGPJ
A1	6QHKLLRGE9J8	C0	Y40WSAAL5J9TU	D0	LRP3X99Z2FA9RV	E0	KK2EDFDZC9U9D	F0	10TGWHHGRU0DS	H0	UY3V6MMJE09FC	J0	5TD4UEEW9Y9SR	KB	WKTFURR5KEGPJ
A2	2R8KKEE9S4X98	C2	ZEMOSMEEV7XF7	D2	E0X83R9Y33XPW	E2	S6DCEFT065X7E	F2	RRVFV33WMSX0J	H2	3Q67HPPCD6XC4	J2	J825JLLGAGXJP	KB	WKTFURR5KEGPJ
A3	CMW3K7T2C07T	C3	5WGSFGETKN08S	D3	T2N0333KTU00Q	E3	ZHCLFEEXA0E0SH	F3	3WEWRRR9UAPU	H3	92R2600XWMO95	J3	Q2LNUDD6890J4	KB	WKTFURR5KEGPJ
A4	8VYCK55GD05VE	C4	ORCPK5K3Y54Z	D4	549F3WMTU05AJ	E4	AQWKFEZ28W529	F4	ME08WUUP25NM	H4	4U6ESHV4S0Y5F	J4	LAF6UJL90J5WA	KB	WKTFURR5KEGPJ
A5	7H4SKDD3J5VUF	C5	KCF5S00DWLV9J	D5	DW5P3HHNSVSDZ	E5	YML7FLMLC4VJ4	F5	HZ70N996E3VR7	H5	9PGCH44V0MW5E	J5	XXC0UUTULFV7D	KB	WKTFURR5KEGPJ
A6	CDCKM7J7VM32L	C6	9H3ZSUU7SS3NJ	D6	7P6V23YRDL3M5	E6	H584FVVGX62YR3	F6	YDYXWKKF8734G	H6	KXSNHXXL353Z0	J6	4FQUC0COP3XGM	KB	WKTFURR5KEGPJ
A7	JOMUKPPATV2C7	C7	6Q8TRSRPH82PK	D7	PK63RUFNNPD2K3	E7	83R3UFNNPD2K3	F7	M6SDHHEEQRL2SA	H7	23Z6F699V66Z82	J7	27FQ88S3X26F	KB	WKTFURR5KEGPJ
A8	MA99KGG5Y761L2	C8	NJEU522G646X3	D8	GY5Y3TJ4866WP	E8	P30TF667VL63K	F8	JGW6WQOQJLMD6QA	H8	TS576V9HG6Y4	J8	RVG8UWMETR6AW	KB	WKTFURR5KEGPJ
A9	Q2W4KNN03PXRK	C9	GDJVS33ND2R0C	D9	NM0Y3FEFWS9R8G	E9	6WYMEFP9MORCL	F9	F92WMMV6YRF5	H9	M5NAHTTJUVWR7N	J9	CNRHU44ZUUR58	KB	WKTFURR5KEGPJ

KA	JKXXRRHHCY5TDV	LA	ADVDD226XUTX6	MA	8PWRJCCSVATGX	NA	6E6L944YCLT5H	PA	YX7FEXXQ0UTZJ	QA	K9G7QKKK29T44	RA	FQWZ009EMT9U	SA	9UF08VHVTPTY7
KB	56P8R37UCGHW	LB	MPRVDDVU7SGY	MB	PDZFJ77K53G2Y	NB	A4U79NNZJQNGK4	PB	Z2EGEQXRYRGQS	QB	SF0LQSSSFGJGH	RB	OVU0ZFFRPHG87	SB	RSWR8223NDGX
KC	46P7RSLSC6UHG	LC	6RWDD0DA6JU0Q	MC	Q0YUJLLHNSNUJ	NC	AHSJ9JYJRY3UWD	PC	R2G5YEPBP0PUCG	QC	TDZNO333KTU00Q	RC	WM3RZG294ULX	SD	SKJ28TTSU00U7Y
KE	DE50RG88RS17	LE	26JYD449PTS5G	ME	CKC2J880T2S65	NE	9WVK922MGSX9	PE	M3GQEEELCMSSQ	QE	FU7HQFFD3J88	RE	KH8ZSS67VSHW	SE	6TLLXNNGVSKV
KF	206Z000QLD8Y	LF	95CFD7JZA98WJ	MF	LCJ0200GHY8QW	NF	ZQXM922DURX8U0	PF	ULZDE77C8K826	QF	WU56QWVW308AA	RF	3B82ZHHZAZ8D5	SF	A94T8550SC8VK
KG	N5T2RKKEKL45	LG	00FDDTMTZL72	MG	XRR00JEE3GLLS7	NG	MMHN9559UALV0	PG	9YN9E88FC6L62	QG	H89JQH88H81DD	RG	GKZKZHHWYAEAL	SG	Y7YR8D50KORLU
KH	7WGYRMM5AVDFG	LH	342D0XKLYD27	MH	TEQPJ5J049DVZ	NH	KP5A9E98F8D3N	PJ	G7STE22V9HDHX	QH	6AXUQ666NAD33	RH	9C4VZRRFQRPDC	SH	FJ68D8QOMJEDQ6
KJ	C209RAAJ9QW72	LJ	HEDWDQXS8GWOU	MJ	D4EQJ3J6DFWQ0	NJ	SDNU91LLWETWJ3	PJ	WJH2EVV2AMWY5	QJ	U3PAOUUUT3WNN	RJ	R5JDZ990COWR6	SJ	OGV88XXA24WZC
KK	8EVRZ2DZHZ4EC	LK	GW8D1L0Q14JW	MK	JZ3FJDD9274UJ	NK	06949Q03704QR	PK	39PRENN46V4KX	QK	RXH5QRRRVX4PP	RK	UPYZZ66SLC43G	SK	SLK98EEZDZ4S2
KL	FEDKRVRNTJY9	LL	XJOAD33P3RJO0N	ML	U79NURKIMZJP0	NL	FX309WML0QJJA7	PL	LE4EEAAWTSJTM	QL	D6RWQDDDA6JUU	RL	JLS7Z557WYUJ4	SL	7RZL8HHVU7JDH
KM	K7MLRNNU5UPKH	LM	E9E5DW7K5FAP	MM	RNF6JU05U4FNA	NM	738X993XGHF0V	PM	QWRSEZ2VY8FEF	QM	9248QJ6J6JFW	RM	DGXHZTTPNF78	SM	P55K8GGMNFFL9
KN	PE7DRYIT6MKR6	LN	WZUXDEEFCNKSV	MM	5WKGJTTRJJK7S	NN	FKZ593XHXSKZP	PN	HFZXZ44NZQK5Y	QN	90Z99952KRR	RN	60RZUUK85KN2	SN	KN3Y8LLY4WKJG
KP	AGLSRCH32CGF	LP	JNAMD994NZCRL	MP	GLH4JHLLRCDR	NP	48RF966TDCP3J	PP	TC8LEFFQF3C8H	QO	EM3GQEEELCMSS	RO	XZCZQ02V9CQE	SP	23E8RRC7LCPM
KQ	YMWCRPPW3QCE	LQ	TGVNDUUVVEQNO	MQ	3YXAWWXXCQAN	NQ	VUJP9RRJJ6QZP	PQ	JKHSESSK2Q8H8	QO	QOQQQQQQQQQQ	RO	QOQQQQQQQQQQ	SQ	NEP3866PPYQ3T
KR	XH5QRRRVX4PFP	LR	FVKTD77WYAP2K	MS	K2U9JYVYWUPY2	NR	WCGE9P567PCM	QR	S8V0EJU57WFP7	QS	ZY6CQZ2ZGYPFE	RR	APFGZMM36PFS	SR	3AMF8CCRFQPGJ
KS	RAY4RXFXJLHJR	LS	VXX7DMTSHHF4	MS	K2U9JYVYWUPY2	NR	TJCV9Y4W5HMC	PS	4DU6HH32YHDA	QT	8W2DQ88UWH66	RS	CTEAZ7750SH2N	SS	5HTU8AAAXA2HT3
KT	3S3JR55MGJ7VD	LT	7NEDDFE2678M	MT	7E8HJUMMNQ0F8	NT	ELDT9KK85E7K4	PU	8QFAE998SF7RN	RU	4RL20444XR755	RT	2XV6ZVX4A7YA	ST	X67M80058879L
KU	TDHWRWPMONAU	LU	YK49DNNRE8NK2	MU	76L1JUPFNXNCK	NU	RZTH9Y8A8Y8K	PU	AA0PELLEP5NJZ	RV	07EKO0047N99	RU	SM2ZKXUXQX4Y	SU	U8C8844W56N5W
KV	VRARRFFX8P78X	LV	RCLGD55Y9FYVS	MV	ES43XKXW0GIZY	NV	YVP69T16M2Y7A	PV	6N9VECC7L6YGC	QV	GSNMQGGFSYLL	RV	HQJ2333M6W1OK	SV	MFU28JF6G5Y5W
KW	HUKNRJJAS7AWO	LW	C85CD00LJKA9E	MW	ZT7KJAA4CHAT9	NW	LN229SPSPV4AH5	PW	PVWUERE9G9AP3	QW	Y0CTQNNN70AKK	RW	V2TMZ22Q3AXL	SW	K3Q68FFJLTA8A
KX	QWMPR9927E9Z8	LX	03D2CCG03ZG5	MX	4VMYJ22K3SZXG	NX	G50C988KZJZ6E	PX	KTTWE55XZJZVU	QX	YGAEQYYSZGMM	RX	MDWFZAAHRKZTJ	SW	Q3UG87793Z2S2
KY	KYC3R773FXM2T	LY	5L66DRRNTWMPA	MY	WNS5J33EP0M0P	NY	NTY9G9UUD4DMNS	PY	D5Q7E0073AM94	QY	LHKFOLL18HMJ7	RY	QJ9EXXV5FWMZ	SZ	VWMC89977XNMR
KZ	LV9GR664EWE3S	IZ	SH8RD88HMXE6X	MZ	2MDDJ44A38E56	NZ	HRE39CCF9EGE7	PZ	FUA8ETDTP4E7W	QZ	MLTSQMMHLEFF	RZ	Y6CQZZZGYPEEQ	SZ	GXZP8P6KMECZ
KA	W88MRTTY0997L	LO	P99SDKXDD94F	MA	MS07JYVY8V9M4	NO	XGMZ9PFCNN98Y	PO	CHL5E66U7793P	QO	36GNZNEJ29K0	RO	43CNZNEJ29K0	SO	EDP88SSST9S9H
K2	Q76RDLZHFZFA	L2	8S23DSQ4PXHT	M2	AOGLJZ22LQXHE	N2	QYUR9007TZX9X	PO	7KMDJUEU06JXNR	Q2	VCMZQVVECXKY	R2	NAAJZ44L2XX5D	S2	LPON8KDCUX40
K3	6X4ARLLSD0JN	L3	4AHDZ2JQV0E9	M3	03ACJYSC9D0HE	N3	JFFY9AAV300TG	P3	VKDJEWGWA10AD	Q3	74M9Q077R4022	R3	PSG4Z88DST06R	S3	DV658YYLZ30MP
K4	93R5RQO02NQP	L4	22PLDADAGM5TH	M4	SXT33J008Z659T	N4	D7LD9Z2NKC5E6	P4	NPMME33HJG50L	Q4	PZDQPPPY25CC	R4	8007ZCCJHUSG3	S4	JMYA8MMQ9X5FN
K5	U3JUREEK4GW53	L5	N3SHDYY5HQVW8	M5	FA6EUKK7APV4M	N5	59W99NME2FRV7F	P5	26G2EGGNDVNL0	Q5	CEUYQCCMEVGC	R5	7805ZPPTG8VCP	S5	TQ4A8Z8Z6AVER
K6	092HR229T83X8	L6	Q7HGDH8F03D3	M6	6JZJY99DRWR3RD	N6	82KMG6GGEH3VLU	P6	E4JCEEMANU3FE	Q6	TKY0QTTT9K377	R6	5NHLZJJCCKG3WH	S6	C0978332YJ304
K7	SJUT7446V5254	L7	KMOZDGPWC2LR	M7	995M66JMEY23L	N7	CAQ89HHXSM2DM	P7	XZ3YQ5525P2MT	Q7	TYPKZD552P2MT	R7	W2DQ88UWH66Q	S7	CN8H8WW492A8
K8	EOZFRUUNPZ6NJ	L8	FM02DPP3R26CY	M8	VH2VJNNMTE16K	N8	307S9770AF62F	P8	05XEDDTEET6UV	Q8	ANV30AA0N6TT	R8	ZKLPZYWUD6MZ	S8	W2DQ88UWH66Q
K9	ZFEER88GKAR6M	L9	DYTDJ66254R3D	M9	HGPUJGGQ75RL3	N9	2S4Q99952KRRQ	P9	503KEKKSWXR49	Q9	XV8PQXXXCVRZZ	R9	EF53ZLL4TJRJT	S9	44XS8UU8EGRNF

MS32 Checksum Table

TA	50J4Z4Z3DETD	UA	ZGHA0NNF4ZTKN	VA	33KVGF5FG5X1T8C	WA	UHNTNOOD3JUTQK	XA	P08HYDD89STU8	YA	VFZSLYYUQTMF	ZA	MRDEMLLN03TJM	OA	W59U2SSM8CTH3
TC	J5GN4Y4Y44GM0	UC	YYSU0440DWG53	VC	HA3DG00WV2G96	WC	6M52NXXTF7GZ5	XC	8RQKYTTLAUG79	YC	2993LZ26CGGET	ZC	A02CMEE4HAGSE	OC	GCZA2KKAL5G4N
TD	NK9L499K3HURH	UD	9XA5055WFVUFV	VD	KLUPGWM0GGU4Z	WD	MEEXN892DUU6JV	XD	XPD6Y227E70XA	YD	T78GALRRMU2UPN	XD	U585MCC5VNLUGP	OE	EY702XNND20UK5
TE	TOEM4AAW2W8TL	UE	ALP50VVKJ4XVP	VE	WX09CKKHN3S42	WE	Q0ZNNLLJK9S6Y	XE	7C37YJJKZ8SM4	YE	N75ELMMR8NSFM	ZE	Y5MSMQO5VXSQF	OF	3RNE4200YQ0S9R
TF	VDNK466FKQ39	UF	631E0T13WM87M	VF	FG2G333S0L80S	WF	IW00NCC4218G7	XF	EKMNY4427F850	YF	5S75LUUYNA8NP	ZF	R03AM88T5G86N	OF	KDEC2GGRUP8LE
TH	Q46Z74RRSEMLP4	UH	T2630JJG3QLWT	VH	SNMQGGF5YLLQ	WH	A478NPV4SLCW	XH	QD2M1WVCPJLYL	YH	DT0UL99AXLRL3	ZG	6PQ4M77JTNL2R	OH	OKGS2336R6LOF
TI	COP54WMA5PDAF	UG	WSEL0L19V6DJH	VH	AFWCG99YD7DRU	WG	SOAFNVP62D1Y	XH	DHF4YPP4UGDCR	YH	Q3VJLGLGSEUDL	ZG	6H4MMN1LKFDKL	OH	ZVT72UUH7QDN4
TJ	7XK34GGMVDMLT	UJ	GU770EER5KWS4	VJ	M9L0GRRZ4JWP7	WJ	KR6GN238SXWS	XJ	TMW5Y88NYW6P	YJ	XATNLWKP3SWA0	ZJ	3HY6M44EW9W5A	OK	YOVL2663XVW3H
TK	PNSC4HHYT64DE	UK	HTG00XXUNP4Z8	VK	YJFXGUUAJ94NV	WK	F5VPN44CH3345Z	XK	5VCAVCCVRN4GN	YK	XEA6L133FX840A	ZK	WQJNM22XJ4X0	OK	MH6E299WPM4R9
TL	08Z4E26DESJY	UL	EH0DDGZAJA16	VL	2WAUGJ0JNREJW3	WL	8GCMNMKXKDJFL	XL	6S8Y8KJZ0J04W	YL	HKF0L18HJWJQ	ZL	QXQFMYIGCWJMJ	OL	4TW2TITQ8J7C
TM	SSJ744X4A3ZK	UM	QX2Y0HHD92FDG	VM	4ET46GDYWFYFUR	WM	CLWJNYFP6FMD	XM	986WYFFA4CF8U	YM	LPFLQOC5VFQJ	ZM	LTFSCMMHLEFFQ	OM	2UC9255LH5FV2
TN	8HHE4433ZKNK	UN	380K0Q06T2DK9	VN	Z7W8G6M2FK3W	WN	Q0TQNNN70AKFO	YN	JOLUY774KDLK3	ZN	GL6MLH007TKDL	ZN	GY4JMVQV37KYL	OM	AMAH2RRGEHKP8
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TQ	ZARV445588UQC	UQ	5DLR0818LQRX	VQ	857JGL77RQJD	WQ	2KPM4NKKMMHQ4R	XP	H20FYEM004QFJ	YQ	62WMLJJ22PQWU	ZQ	DY98MFF99S08W	OP	C3D22XXDDAQZY
TR	Q8V54KK90CB4P	UR	K9M088AHRP6L	VR	9SY2GAAU8P8T5	WR	GJPD235ENNVP6	XR	4W43YEEED83PST	YR	CGSKLJ2239PH	ZR	02LLMTT8DSP7H	OR	64HG255Y09EPMA
TS	9NDP4ANNJHKZ	UT	PWF07SS2REFHEU	VS	Q65LGCCEZDGHG	WS	D23CN3308EH0E	XR	5S9Y9YUWGF7XG	YX	Q4YRL44DKOH5X	ZS	2G02MMWZ6HA5S	OR	LL802PNP23NHC7
TT	W9F4CPJPL7CV	UT	RMR07SS2REFHEU	VT	JHPG622TCQ7XE	WT	L3LYLNRW457PH	XT	ZFSRYWUWGF7XG	YT	004YL81V276G	ZT	C96DMUUSRH7N6	OT	DJUG2NNCT77KS
TU	DP764MMGJZNA	UU	MNX4022S2ENXR	VU	G28YSSS3TANHG	WU	9VZRNEE5WFNSX	XU	C5KLY5506TNVH	YU	4JNCIAA91LLNTE	ZU	ZCU3MXX2S2NZT	OV	H0552FFZCRN8P
TV	2D5H4UU0WVYN8	UV	UAVCDDDDHKHYUE	VU	0YDFGHHKNYD1J	WU	ZZGWN77NJ8Y2U	XV	L60JUNYX89YKD	YU	JUE4L66ZBR3Y3R	ZV	9KAKUMPPDYIC3	OV	SP7E24W9YDIAM
TW	3JL84885ENAGW	UW	8Z8G0KKVP6A4S	VW	5MXEGVWDQVAYM	WW	EAR7N99G9CAR4	XV	Y9HZYGGU36ALY	YV	FRJ9LPPESWAC2	ZV	7FAV6M66KMA3C	OW	T74F2447NJA5J
TX	X4644SSRH52HR	UX	S2620PPM00ZCA	VX	RUMG6PQAKOC8	WX	W6XVNFJLTLAZJF	XY	NZ3SYLLTLAZJF	YX	7YHHLKDW6FZ48	ZY	FWC7MDDP4U2U4	OX	UEGM2ZZFA4ZEL
TY	A2394TTCOTM72	UY	T6F2066QCSM35	VY	CRGMGOQPE5MOL	WY	49DUNFFYUOM83	XY	GAEQYXY5CZMMQ	YX	9MU8LDD4DKMUM	ZY	J3NMWKK6ZRM4U	OX	8XMT2EEJ22MSK
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T0	GFW0477DXG927	U0	7EK0000471N99Q	W0	DQH3G445LH95T	W0	QXJKN2036R9N5	X0	A7X2Y339WEP905	Y0	SCRDLCCT49G6	Z0	8JUYIMR0FYQ9P2	00	J9YF2VV8VF9Y2
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T2	UGUJ422EYFX0F	U2	2CX0XMPUJ0FV	W2	EP9HGPQAKOC8	W2	58QSGN9G9C20X	X2	FL5VY993VQ0RC	Y2	7Y3LTV5F50YK	Z2	NN7ZMHMHPODY	02	XJY82CCNMG0GW
T3	RU2Q444X755Q	U3	4J0J0Y7M95M7	W3	XKN7677L6P524	W3	TSKENHHG145DM	X3	KGZ9Y66MTH532	Y3	WM82LNNW55K	Z3	VYGTMGYPK5LK	03	ENQW288VJ156U
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T5	FTRR44LQV23JX	U5	LMV00WM5633AC	W5	V26AG554M43VN	W5	PYL6NAAZ7P3TA	X5	UTXYSSJ2383HV	Y5	36WPLEEP0H3SZ	Z5	5XPGMZ223ZES	05	N8LFD2DDJG02U6
T6	KU424QQN9A205	U6	GU93033TAX202	W6	N4V5GT7U2Z27P	W6	F7N6N220EK2E2	X6	RTAU0Y00MD5297	Y6	WDGCLX7GQZ2TS	Z6	7E3HPMAA3842TZ	06	7SY22JJE0U2WG
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T8	Y3QD4JJPLSRW6	U8	JPCZ0RRE8TRPY	W8	PCENGECECX0RS0	W8	V7U5N5SSARHETS	X8	3XGGYAAAFHETS	Y8	UQD0L55VUDRV7	Z8	T2ZXXM00RACR9V	08	7A2R2QQ0T43RQX
T9		U9		W9										09	

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2E	EYVQVDDCUX5UC	3E	G6F37RR76USPT	4E	JYR1P335AS0H	5E	O84GCP2P2XHS0Z	6E	24WATHHEAQS0N	7E	SEYN599NHP8R0	8E	VN8FAZZS5DS5EJ	9E	PAZMXV243ES7Y
2F	729P222LQ28X3	3F	OXRU7YIEAXJ8M3	4F	42FJDPKKNM84D	5F	8FL9CXX96E88Z2	6F	DMYSTSS7P8WHF	7F	HHW75Z25108E4	8F	T4DYA99HGR8R9	9F	XNGRXVVDJH8YX
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2K	NCX0V88JAS467	3K	ZUQ77FF5MG48D	4K	CS2DPMW73F4F3	5K	2NUTCITG8R47K	6K	OP877AANU54T4	7K	6DSD500EK449F	8K	XW2AGG64E4L5	9K	TFTDXPPLSD4C6
2L	XJ4VFFVUVJ38R	3L	VQ5G788625J6S	4L	KV7XP44SQ4J5V	5L	Y0G3C99XKLJRT	6L	WANYTNNADJGJK	7L	53E25PPH8FJCS	8L	GN6SAXX5Y9JZF	9L	94LHX003P3J98
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2P	FQNVAAAGWCT0	3P	CPXW7NNWG4CKU	4P	ZDVQPPYZ5CCQ	5P	SW6HC33J57C08	6P	6UPZT88QFC6Y	7P	QSTV544R9C5C	8P	UJGKAJJOXYCW9	9P	35D3XMM9RSCFT
2Q	S73MVYI33KQML	3Q	P6HX722HHWQXV	4Q	MKAGCCCAA0QGS	5Q	F4TLCGGIT9QLH	6Q	R8S2T775SJQ25	7Q	ET65V5V66NQYG	8Q	9EE7ATTEELQ74	9Q	G0UEXZZUUTQEM
2R	J6TRVXXNEJF2X	3R	R7D77GG4L2PL4	4R	EJ8SP66L4TP3F	5R	T338C22FRFPXW	6R	PR2JTUUUCKPND	7R	M0Q05WMCJHPA3	8R	8DRXAFFM3MP8V	9R	2TXFXQ750PQZ
2S	HGMKVRKDCDHP9	3S	X5AT7DDSTOHUK	4S	UCH9P16LPPHJ2	5S	WMPJCOOVHTH9D	6S	YF68TEEHVUHSW	7S	79SF5TITAXH7J	8S	Z8NNNAV793HYO	9S	OPK5X99MQ9HRP
2T	9AM3V33YH470T	3T	SEGV7LLZ3D7JC	4T	W4Z2PDGDMV7UY	5T	UK54CAA7DX7TR	6T	KYQ0T19K3770	7T	VG9W5EE0057SU	8T	S2X5A77VLU72P	9T	AVRNXHHF6G7D0
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2V	LMQVWVEVCXYQ	3V	F2YA7ZZL77YEN	4V	XNWNF5545LYH0	5V	P9CYCQRZ4Y4T	6V	THR3TKKEZCY4T	7V	3MF5LJNNRJY47	8V	DE29ARR30YIP2	9V	QLOX22254MYX
2W	3R3SVHHZ0EADF	3W	J4OD7EYEFYPAS6	4W	GE9RPTTWQ9A7X	5W	66N5CMWC42AFP	6W	SGGPTDNNRAAUZ	7W	ZY205LLEFFUAJ7	8W	KXP4ACCD28SAGR	9W	MQJXJX330ZAYD
2X	5KYZVQ04P72QY	3X	9J2L7WNN8XZAH	4X	LQ3P9EDD8ZNT	5X	DAKXVCY0MDZVY	6X	80DNT66506Z30	7X	AR4A5GG72MZLN	8X	PPY8A00AFH29W	9X	78P0XCCXCVRZ2Q
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20	26CCVWMS29AE	30	TW977QQAQ69Q2	40	325T7PJHJUM9WK	50	RP20ZCNP2739E3	60	FNEFT5563X9VJ	70	NLN855XCSMS92W	80	0ASAAPPCNT9CN	90	ZM46XGGKAL9LA
21	UXLEVGAGWALM	31	DZEX7YXMMWXZG	41	HWN2P535YHXV5	51	9D9AC9Y8JAX0M	61	0LTGTJUF2XWS	71	4N555QQRKTXQV	81	F3HUA844Q8X63	91	YHJXWMS9N9XAL
22	WT27V660JRO34	32	LOVR755F5M0VX	42	9RXPDXKR760Z6	52	HQS6CKK4GXS04A	62	AJT0TQOWN80X7	72	87PP5JJYEXOWZ	82	MUZMA4486205L	92	K6HUXU0ZL70N3
23	3UHV99S453R8	33	QC627TKNV575	43	GHXNCF208580	53	GHXNCF208580	63	Z9AXTLL35S5JV	73	CFHG5DDM735US	83	X75JA22CAA5XD	93	4FD34XRRACF5PR
24	G9DLVUUF20VNH	34	ER127JUOVHVWJ	44	R0PVPQ0XKXVQC	54	3VHMCSSNSUVHL	64	M7WITXJGTIVZU	74	PJXQ5552P2VUQ	84	A596ANNPZVAKA	94	SKQAX668JVV3N
25	MG45U0065Q39P	35	2VNZ77PUJC3CJ	45	Q8E8RNNKCE3KW	55	ZR0SCRRQWN3PF	65	G359T44N4Y352	75	JA7T5883L936K	85	WLA3AQOJUF3QT	95	RECKXFF6EHA389
26	YLRASV9N9H2HN	36	4M90777R4022Q	46	OH0WPFVFWLW2J	56	A5EECCUULFY2NM	66	HXZVT22YJN2XC	76	D2GZ5CCMCJ2GY	86	7DZG5CCMCJ2GY	96	UWUWKKKK7224H
27	DDA2VEEV7965S	37	UFMH7HH2CA6D8	47	X93EP99QJUM6R	57	58WEC44KYK65U	67	75UMTR2RDL6PL	77	YCK453384060R	87	C640AKKYV647	97	4USUWKKKKLPNC6J
28		38		48		58		68		78		88		98	
29	KJ6VZZHF6REA	39	8KS97VV30ZRYW	49	A66F777M9RR2J	59	0EV7CWNDFNRA4	69	9THITCCGK7RGK	79	L8A95522U2LBR2	89	R97LADDLPNRUH	99	WRMCXYI6Y8RME





# Translation Worksheet

The translation worksheet is used to derive shares when splitting keys, and during key recovery. In all cases, the process is to translate a set of shares using the translation wheel, and then to add the translated results using the addition wheel.

**You will need:** translation worksheet, translation/fusion wheel, addition wheel, recovery wheel (i.e., for key recovery), and the derivation table (page 7, for share derivation).

In all cases, the number of shares to combine is your  $k$  value, the number of required shares to reconstruct the secret. The process is:

1. Make sure that you have completed checksum worksheets for all input shares.
2. Look up the translation symbols for each share, either in the derivation table or using the recovery wheel and fusion wheel.
3. Mark down each share's index (the sixth character of its header) and translation symbol in the appropriate squares.
4. Character by character, translate each share from its checksum worksheet to its row, using the translation wheel.
5. Using the addition wheel, add all rows together.

Notice that the resulting share will automatically have the correct share index in its header. **If not, you have likely misread the instructions.**

## k=2 Example

Share Index  
Translation Symbol

4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag	ah	ai	aj	ak	al	am	an	ao	ap	aq	ar	as
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag	ah	ai	aj	ak	al	am	an	ao	ap	aq	ar	as
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag	ah	ai	aj	ak	al	am	an	ao	ap	aq	ar	as

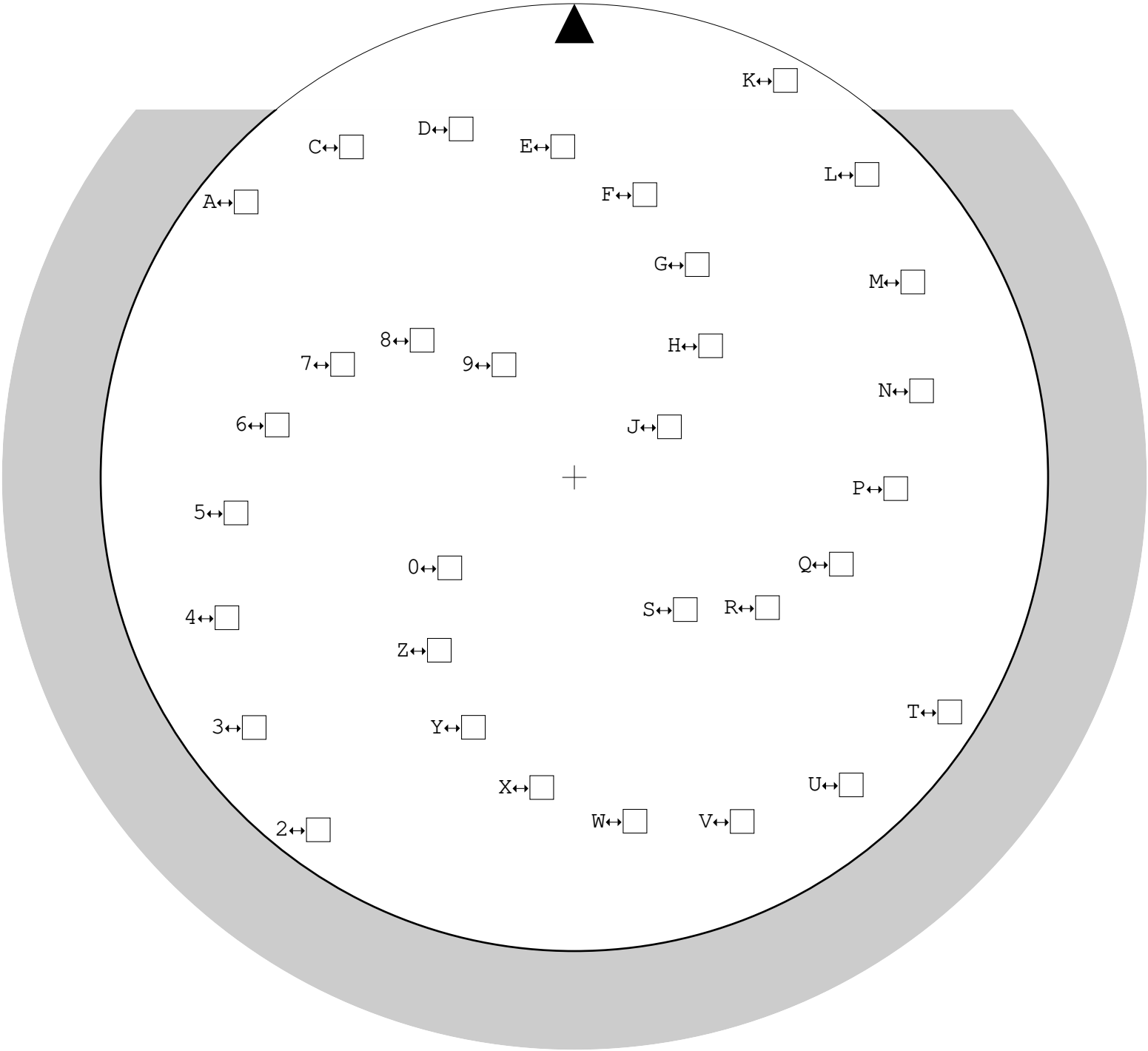
## k=3 Example

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a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag	ah	ai	aj	ak	al	am	an	ao	ap	aq	ar	as
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag	ah	ai	aj	ak	al	am	an	ao	ap	aq	ar	as
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag	ah	ai	aj	ak	al	am	an	ao	ap	aq	ar	as
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad	ae	af	ag	ah	ai	aj	ak	al	am	an	ao	ap	aq	ar	as

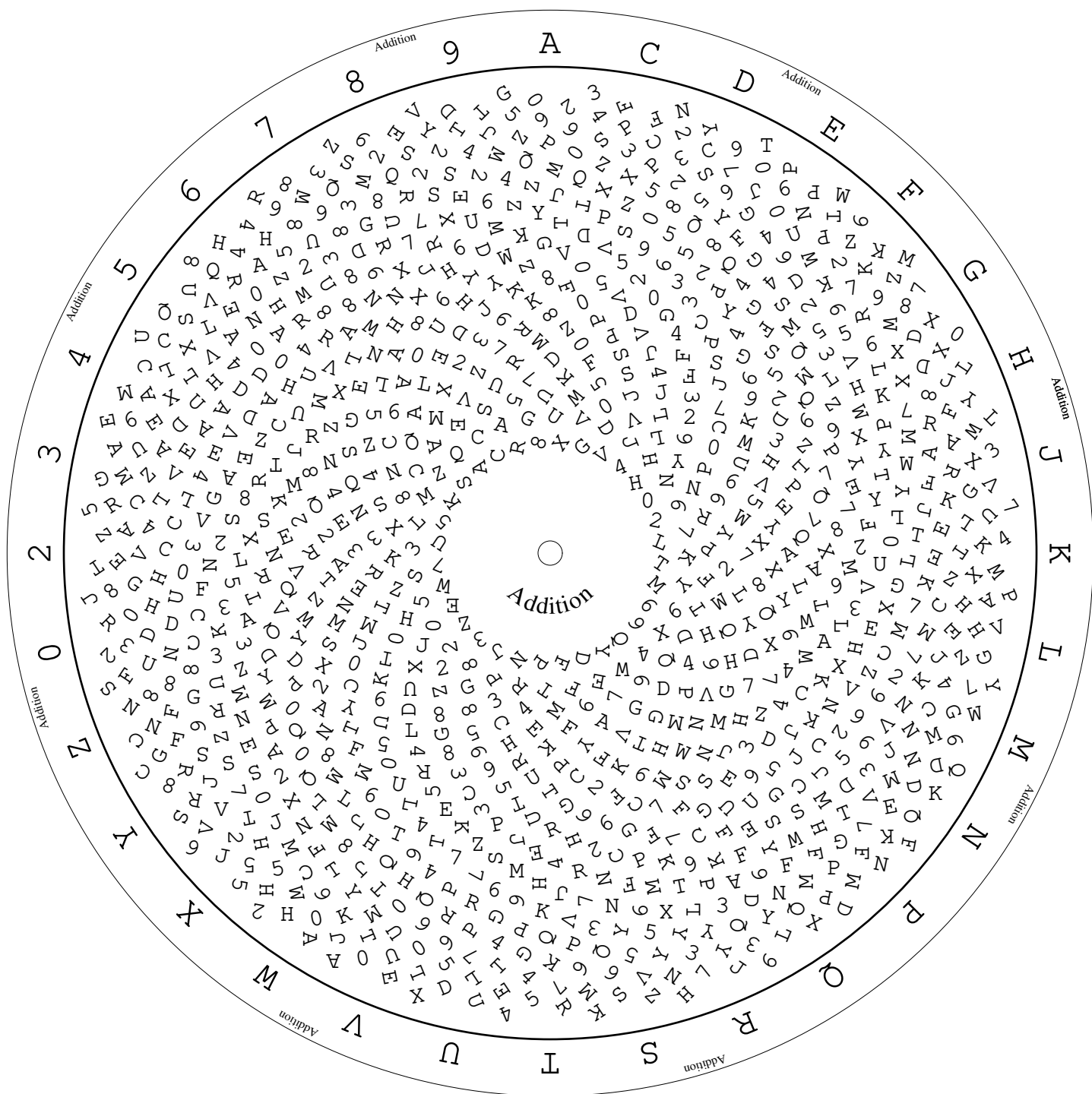




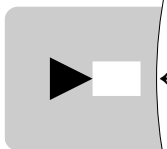
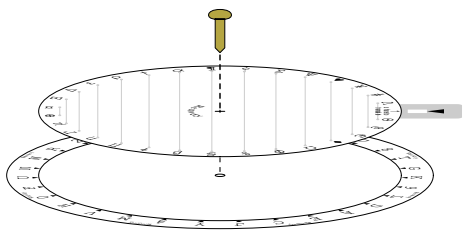
Module 0: Vowelles



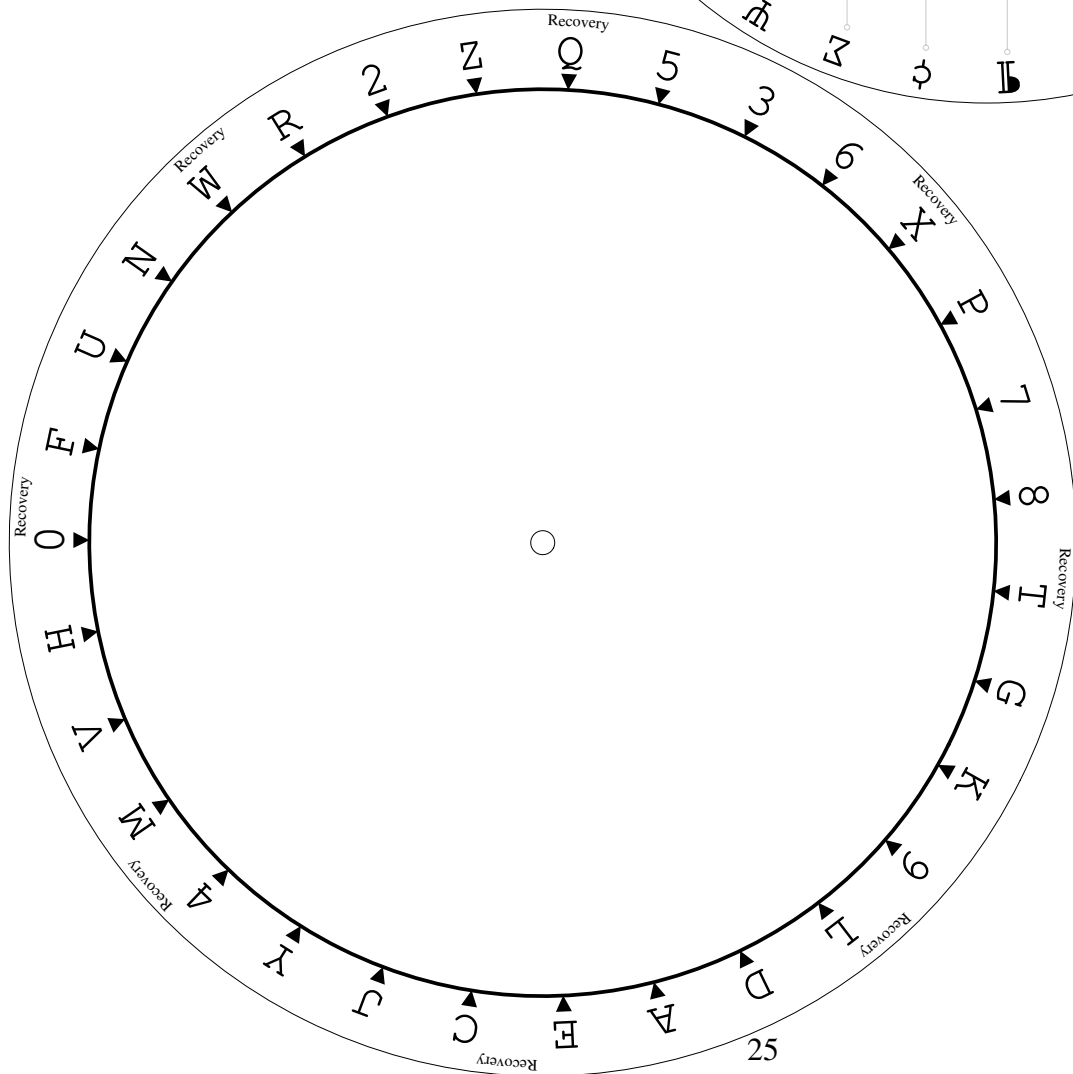
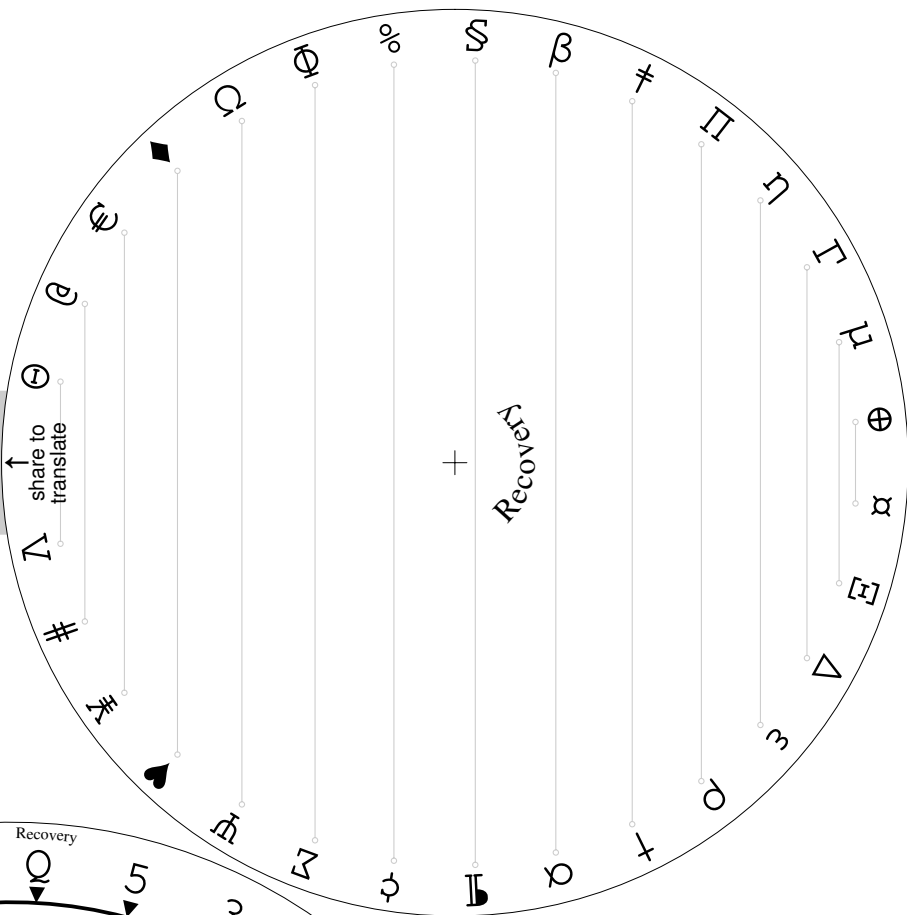








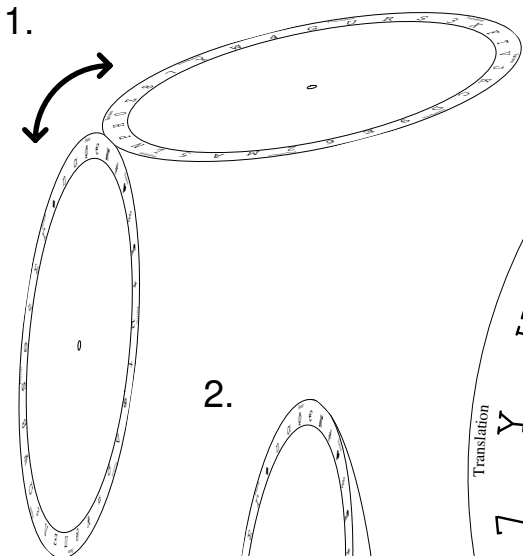
↑  
share to  
translate



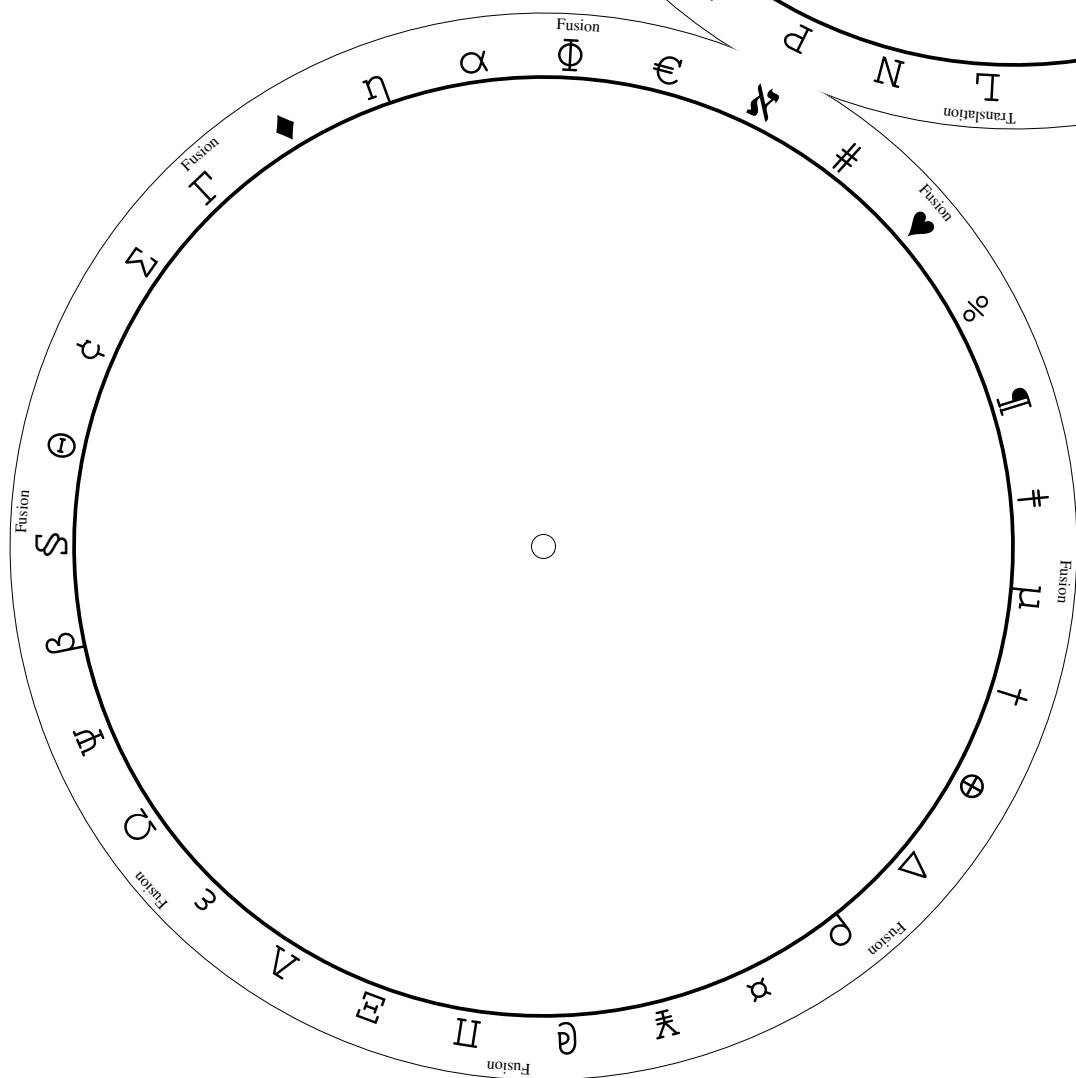
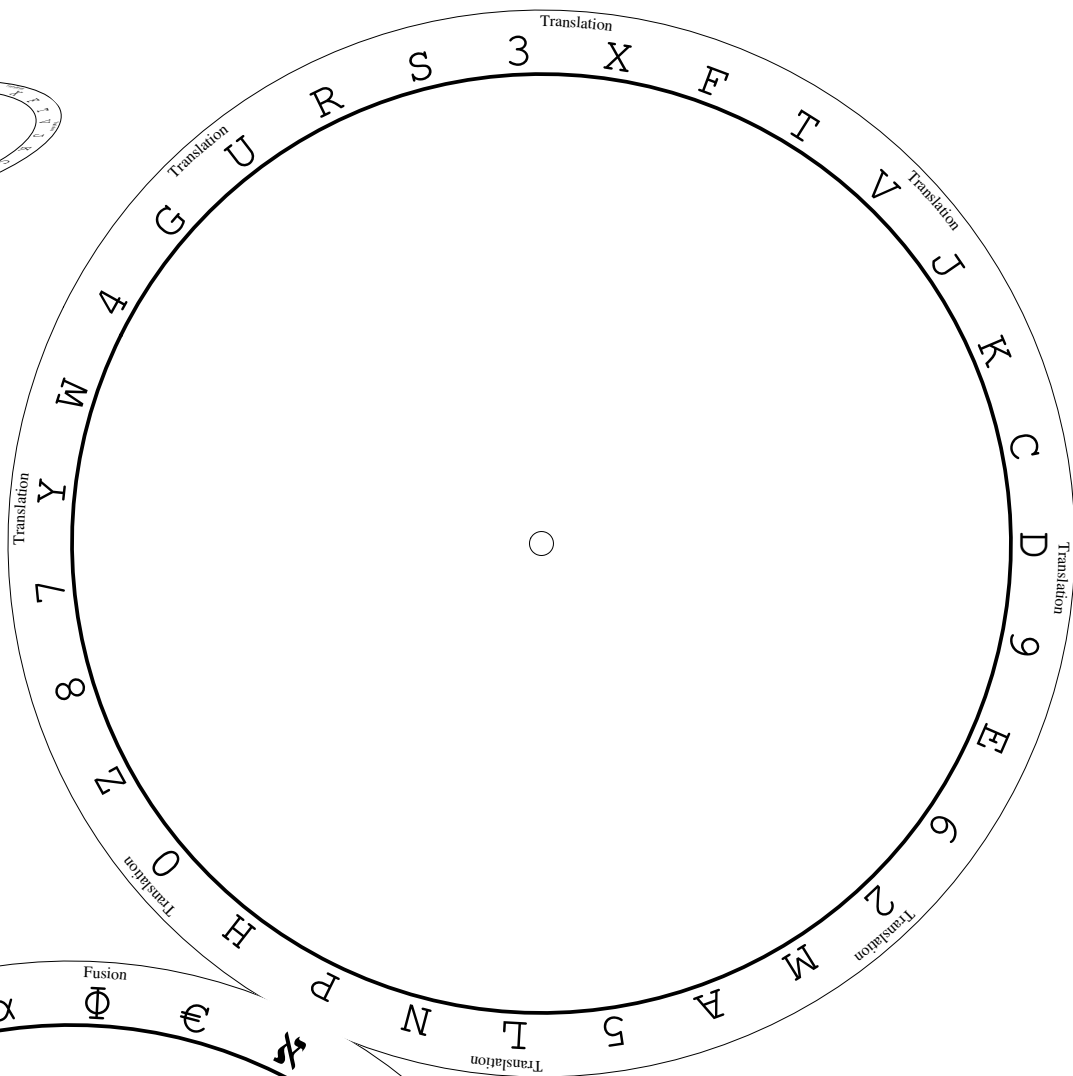
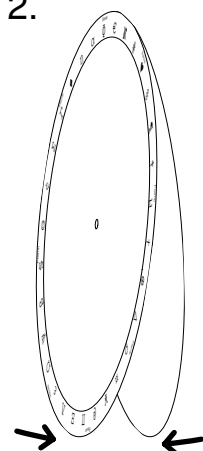




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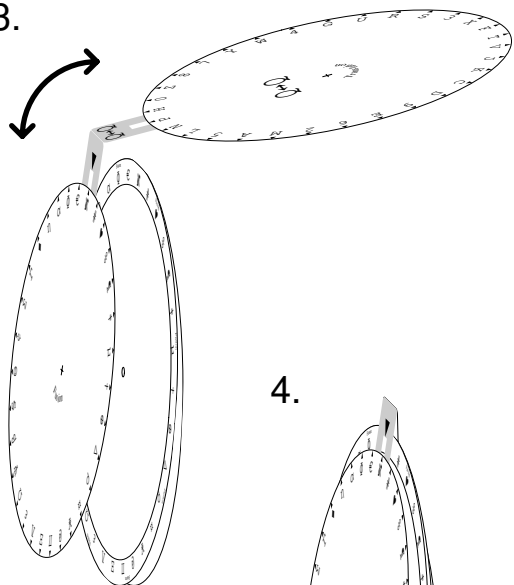


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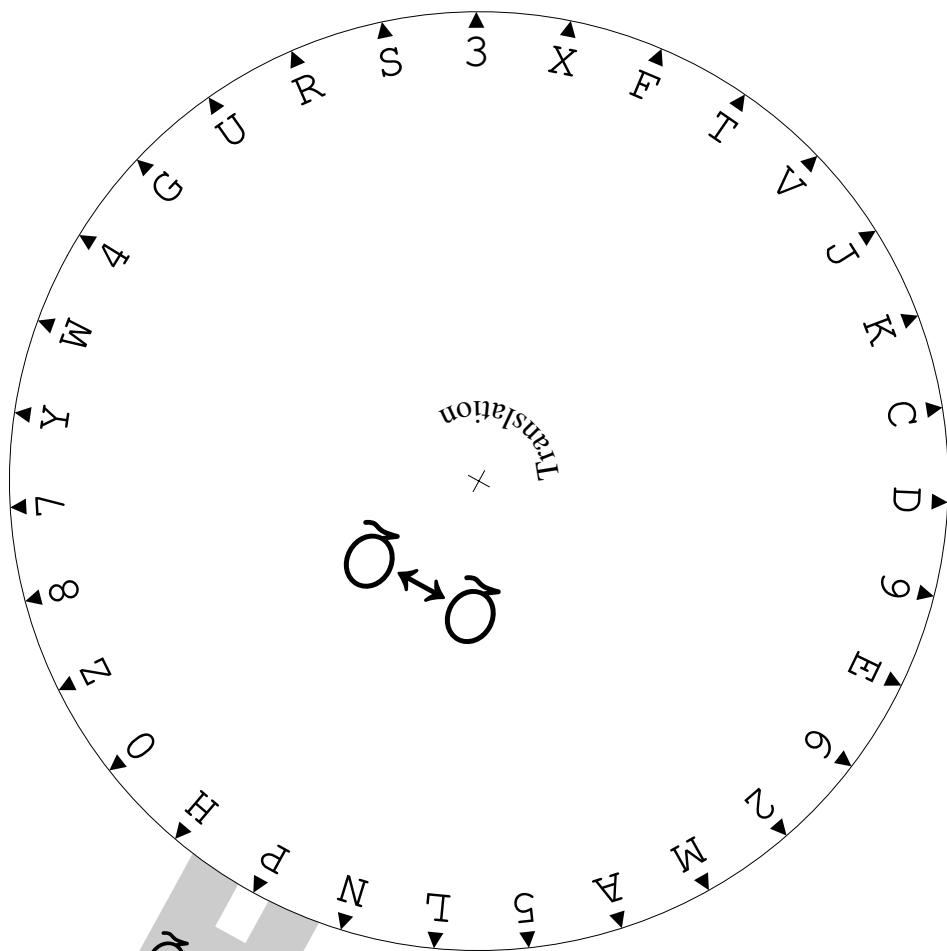
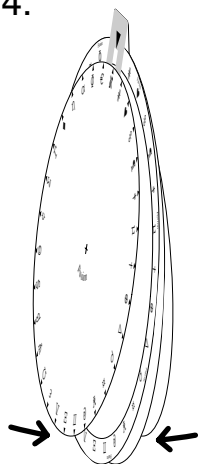




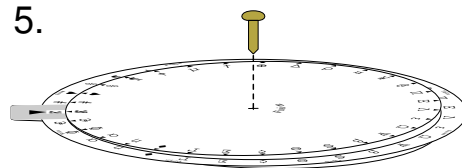
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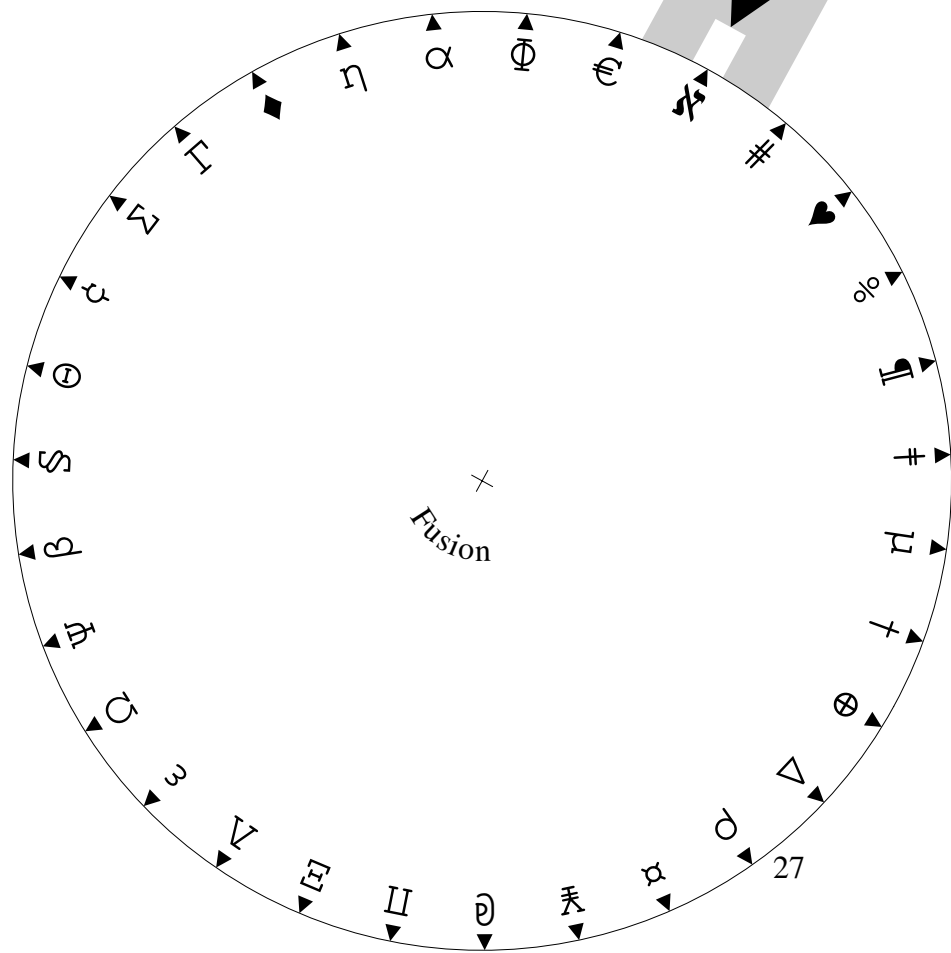
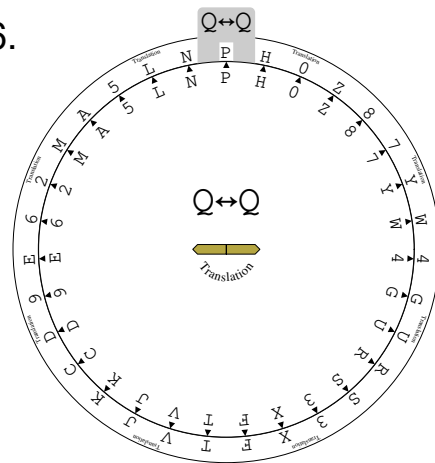
4.



5.



6.





## Module 1: Share Booklet

In the common case that your threshold value  $k$  is 2, there is a much faster way to generate shares rather than using the translation worksheet and the volvelles.

In this case, your two initially generated shares will be A and C. To generate further shares, go through the characters of your A share one by one. For each character, find the table labeled by the character, and then find the row labeled by the corresponding character of your C share.

All of the corresponding characters for the D, E, F, and additional, shares can be read off of this row in the correspondingly labeled column.

We have removed the S share from these tables since this share contains your secret data. If you want to generate the S share, you must use the recovery process.

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S LFU9XWPDK6ZA7MRN2V5JC0QYGTAE4H3  
T E7Y3VX5MCHF0JUZZKRSWAPDL64G29NQ  
U PSLND0J3F2V4TQXZWMAG79CE6Y5HRK  
V QZMA4W5C0NYRJFD2HEXP7KA3UTSLG69  
W 920TPCNJ6MEFRALYJ9TUV6ZCLQ7FESJ  
X 3RDG5PKAHU27Z0E6LWCFNJ9MSVQTY4  
Y 5TEKMDAQ7RS9GLVFXU04J3P2H6WNZC  
Z MNVA2EQW9THPKX64YRLC35DS7FUJG0  
0 NW9YJ7ZG2Q5SX4PECAFVRTH3MDKUL6  
2 06W7LQ9PGVYKH5UTME3N4CAXZRDIFSJ  
3 FDK24GSHXP0YMNAWJ9TUV6ZCLQ7FESJ  
4 RAHLTSXY5KJMO67PFGVDWU2N39ZQCE  
5 4EASCKH7YDLZ2JQU3PNR6FG0XW9VMT  
6 WG2CUM0LJZT34ES7VYD9AQ5RNHXKFP  
7 YCTDZREVQ4KWPSN3HF25LXUGAJ609M  
8 888888888888888888888888888888  
9 Z0NEGTV6WCAUDHJ574SMXYRKQ3FLP2

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CDEFGHJKLMNPQRTUVWXYZ023456789  
A DJQ0Z5YE86FU3X4SL9KVTGCNWRH2MP  
C 3XT402RS9KE6Q8GZUPWNAMJYHDLV5F  
D VQYFP0W8A5XMNTE9GC26RS3KLH4ZJ  
E 8ZP6UVJ24D5R90KLYG3AFWSCQXTNHM  
F XS9ULHC50RMY8Z62N4DTPKEA3JQVWG  
G S50NV3FWLCKAZ2YHTUJ94RMPXE8QD6  
H UNKJCP2TRZQS6YXAED0MW8V54LGF93  
J Q8AG4LDZPWSKT9M06FHYC5XRV3NU2E  
K 2HUAT8M3NEDFLVCQPYS46JWGZ509XR  
L G653DC0YW9N8MKQRXHP52TUZF4EJAV  
M Z24YNQEHUJWC0LRVA6XP6D5F8S9T3K  
N KRH8XEUC34A0WD9JZQG2VPYLM65SFT  
P JE8L2WAMZYGNXSU5V0RQ96FTDC3HK4  
Q YADSEGVPLJ92RCZF5XUW30TH6NKM48  
R H3NP9ZKXTMJGVQF84A5UYED62WL0SC  
S 90FK6NXLG32DP4WURMQCEHZJT8AYV5  
T RC3ZSMNFXUPLDJ0E286HQ4AVKYW5G9  
U MK2Q3J4RHPY95WTDJ0E286HQ4AVKYW5G9  
V 6YWXJFLAD0TZKR8CS345H9N2GUMEPQ  
W LV6CA95QYS3EUNJTFRZGKXHM024P8D  
X T9CMGU30FHZWAP54KEVRJ28DNQY6LS  
Y WDV98S6JQGC4H3PX0TMLNFRU5K2ZEA  
Z P4EWKY8UMQL3FGH6D5TJSV0XA9CRN2  
0 FGSHWR965TUQEMVK32WAK80CPJLYL  
2 4UMDRAZNK8VXG63YJW9E5QLSP0FCTH  
3 NTREF4H9C285YASPMJLKDZQWU6G0X  
4 EMZVHDPK2A6TS5NWQLC80YG9JFX3RU  
5 0LGRYTSV6XHJ4UDNCK8FM32E9ZPAQW  
6 5WLTQXGDFVRP2HA39NE0UCK4SMZ8JY  
7 777777777777777777777777777777  
8 APJ5M6Q4EV0HCF2GWSNDXL93YTRKUZ  
9 CFX25KTGSN4VJELMHZY38UPQRADW60

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CDEFGHJKLMNPQRTUVWXYZ023456789  
A S7RQN825JVE4X60WDZHC3UKGMLPYT  
C V2G67EDASQFNHMIJUX08LZK34Y5TR  
D 3V8XSUQ2GZKJYHRM6LTWPF4NE057AC  
E 6WZ4DLU8QMY2JNVPK0SFTH5AX4RCG3  
F MUXNWYKE64TDS7Q5PJVLRA0ACH2G83Z  
G DCVUAZ8R2WX54K7FEMN3H6LYQP0TJS  
H PL4AFJYXK5SEDCURT2W0V7G3N8QZ6M  
J AT78YVR05CQLUEP3GWKS6DZX2FMH4N  
K HMLJ654UX0AQGSZ7NR3PCT2DYV8WEF  
L 4KH7UTPFMNRWV26A5SQYGC80D3EZ  
M LKXTZNH6FY73CREJ0A8425SVPGDQWU  
N T05GH2J4YRDXE3LVS8F7WCQ6AZUMKP  
P 04YSMANKHJC63VX27GZ58RDWTQEUF  
Q E3WLGZV8F4R5YCHXPA6NK0JUT7S2D  
R 2ASW53CT7DZPMUNE864GXQFLVKHY0J  
S CR2ETQGJA86YKF5Z3UPVMWXHDL40N7  
T 75JDPGAYN23K6W48CQMRZVEFSUXLH0  
U X6F0QPMWZH5VVRJ3N4TGKAY72LSCD8E  
V 8GDFR63SCEMTPLAXZK5Q4UH0WYNJ72  
W ZQEHVK6D3XPST0G4MYRU5LN7FJA2C8  
X KFM5E0LZUPJ82AWTY7DHSNRG4CV3Q6  
Y NP02KR5L47GUQDMCAV6T3S8EJWZFXH  
Z UE6P8HF3WK0C75DYLN2XJ4TRMASGVQ  
0 5YNCLSTHPAVFW8KGRDUJQ23Z7E6XM4  
2 GSCZJWV7R3U0LXT6QFYDKEM48HPN5A  
3 W8QKCEGDUDHANP2LF47Z0MYT65JRSV  
4 YHPRX70MLT2Z8GFSJCENDAVQ53W6UK  
5 JNTV4C7P0S8MZQHD23XAEGWUR6FKLY  
6 FZUY34XQELNGAT80H5CM7PJSKR2VDW  
7 RJA30DSNTGWHFZYQVEL2U86MCXK4P5  
8 QD3M2FWCV6L704SKUHJEYXP5ZNTARG  
9 999999999999999999999999999999

## Module 2: Extra Share Generation Tables

The main instructional section contains share derivation tables for  $k$  values of two or three, assuming that initially generated shares are A, C, and (sometimes) D. This page provides tables for higher  $k$  values; the next provides tables for the case where your S share is an initial one.

Even higher values of  $k$  can be obtained by editing the PostScript source of this document. Search for the text EDITME to find the right section.

We caution users that higher  $k$  values, in our view, are a bad trade-off between usability and robustness (which are damaged) and security (which is improved).

<b>k = 4</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>A</b>	Δ	Σ	†	#	†	¶	†	Γ	α	†	Π	β	Δ	€	¶	Δ	Σ	Ψ	Ψ	ε	Ψ	μ	@	ρ	Γ	¢	¥	Γ
<b>C</b>	Ξ	Ω	†	Π	ε	♦	Γ	Σ	Π	Σ	Γ	Φ	ρ	♦	Δ	Ψ	Σ	η	¶	Σ	♦	Γ	Ξ	♥	Π	Λ	†	Θ
<b>D</b>	♦	Ξ	Π	†	¢	η	β	¥	♦	Δ	Σ	%	¥	β	€	Φ	Ψ	Ψ	¥	ρ	€	†	#	♦	€	Ψ	Σ	Θ
<b>E</b>	Ω	¢	Π	Δ	Λ	Δ	Σ	μ	Ξ	α	η	Θ	♥	Ξ	Σ	†	Ω	ε	ρ	¥	α	¢	Ξ	ρ	♦	ρ	Ω	Δ

<b>k = 5</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>A</b>	Σ	€	%	¶	@	ε	Φ	€	β	ε	Γ	%	Ψ	ρ	♥	Λ	♦	¥	¥	†	Π	¥	α	¢	Ψ	♥	†
<b>C</b>	¥	@	#	#	β	β	@	Ω	Ψ	@	Ψ	β	¥	¥	α	#	Ψ	#	β	α	Ω	Ω	Ψ	α	α	@	Ω
<b>D</b>	Σ	Ξ	Λ	¥	Π	Θ	@	¢	¥	†	ε	Ξ	Ω	Π	¥	¢	¶	Σ	♥	Γ	Σ	α	†	μ	Σ	β	α
<b>E</b>	¶	Σ	♦	€	♥	Ξ	Γ	Ω	Γ	Π	α	α	Ψ	Π	@	α	Θ	μ	ρ	¥	Ξ	ε	♦	Θ	Σ	¢	¶
<b>F</b>	¶	#	Ω	Θ	β	¥	μ	β	€	α	Ω	Δ	Ω	ρ	Φ	Π	Ξ	Δ	Ω	μ	Θ	¢	Π	Δ	¥	†	Σ

<b>k = 6</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>A</b>	Δ	Ω	†	β	♦	α	¢	Ψ	Δ	@	¥	€	¥	η	ε	ε	Π	¶	ρ	€	¥	Δ	@	Θ	Θ	¢
<b>C</b>	η	β	Θ	¥	♥	€	Ξ	Θ	Δ	α	Σ	Ξ	μ	♦	μ	Π	Ψ	α	μ	†	%	Σ	Θ	Σ	¢	Δ
<b>D</b>	Θ	Π	ε	¶	¥	Δ	€	@	α	Ψ	♦	¥	€	Θ	†	Δ	Ω	β	@	¢	¢	ε	ρ	η	Δ	¥
<b>E</b>	†	Ξ	†	Π	Φ	¥	Λ	Φ	α	Σ	@	¶	Σ	%	¶	Γ	Ψ	Θ	†	%	Φ	%	Ξ	%	η	
<b>F</b>	%	Γ	%	Ψ	@	α	†	Σ	¥	Φ	Φ	Σ	¶	Ξ	†	Φ	Ξ	Π	%	Λ	η	¶	Θ	¥	†	%
<b>G</b>	¢	Ψ	μ	α	Σ	Δ	†	α	€	Θ	♥	μ	Ξ	Σ	Θ	Σ	β	¥	Θ	Ξ	Δ	Π	μ	♦	η	%

<b>k = 7</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>A</b>	Σ	#	†	%	€	Φ	¥	μ	%	Ξ	Θ	α	Φ	Φ	¥	¥	Δ	Θ	ρ	%	¢	ε	Ω	Σ	€
<b>C</b>	¥	ρ	Σ	Ω	♦	Φ	¢	Π	Δ	@	#	@	†	♦	ε	@	ρ	¥	♦	♥	¥	%	Θ	@	Σ
<b>D</b>	Λ	ρ	Ψ	†	η	¶	†	†	Θ	Δ	β	α	Δ	Ω	%	%	Σ	ρ	♥	@	€	@	†	Σ	Ω
<b>E</b>	¥	Π	¥	Ψ	@	¶	¶	Σ	ρ	♦	♥	η	α	¥	Σ	μ	♥	Φ	†	Γ	β	†	Φ	Λ	
<b>F</b>	Θ	Θ	Ξ	#	ρ	Θ	Γ	β	€	Σ	ρ	Π	α	€	¶	¥	€	¥	†	Φ	Φ	μ	♥	Φ	Σ
<b>G</b>	♦	¶	ε	♥	#	ε	Θ	¥	Λ	Σ	Ψ	Ω	η	Σ	β	ρ	Δ	Σ	€	¶	#	Π	Δ	@	Π
<b>H</b>	#	†	♥	α	β	Φ	Θ	β	Θ	α	Ξ	Ξ	@	†	ρ	#	♥	Γ	Φ	Ψ	ρ	Γ	@	¥	Ψ

<b>k = 8</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>A</b>	α	ε	Σ	#	#	η	♦	♥	Γ	%	Θ	Σ	%	♦	Σ	Ξ	Σ	#	#	α	ρ	%	Ξ	¥
<b>C</b>	Φ	α	α	β	Σ	€	♦	¥	Ξ	Ψ	♥	β	¢	¢	♦	Θ	ε	Δ	¢	¢	Ψ	Λ	€	ε
<b>D</b>	♥	η	Σ	Γ	%	Λ	¢	%	Ξ	α	Σ	α	Ψ	@	β	♦	Ψ	β	†	Π	♥	ε	α	Ξ
<b>E</b>	Σ	†	β	Φ	Σ	♥	Σ	μ	%	¶	@	♥	Λ	Δ	α	♦	Φ	%	Ψ	η	η	μ	μ	¥
<b>F</b>	α	β	¥	†	Ω	♥	♥	Θ	η	Φ	¶	@	α	α	♦	Φ	Ω	Θ	β	ρ	¢	α	Λ	Ξ
<b>G</b>	Θ	β	α	Γ	α	Π	α	μ	Θ	†	μ	ρ	β	Γ	Θ	μ	α	¥	Σ	α	Φ	Λ	Φ	μ
<b>H</b>	¢	%	¶	α	Σ	¥	Φ	η	η	€	#	Γ	#	@	α	α	η	Δ	μ	Ω	†	Ω	Π	Δ
<b>J</b>	α	Π	#	¶	¥	α	@	Γ	Θ	β	ρ	α	Ξ	#	Π	%	Ψ	†	μ	β	Γ	Ψ	Δ	Θ

These tables allow you to generate shares in the case that your S share is an initial share. However, in some cases, you need to generate the S share first, when using an existing seed with this scheme.

<b>k = 2</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>S</b>	€	Δ	Ξ	Σ	@	η	Ψ	†	Ω	†	Π	α	Γ	Λ	♥	§	⊕	⊖	♦	Φ	ç	%	β	¶	¥	μ	ε	ρ	α	#
<b>A</b>	¥	Γ	μ	Φ	#	ε	Ω	†	Ψ	†	ρ	⊕	Δ	⊖	♦	¶	α	Λ	♥	Σ	%	ç	α	§	€	Ξ	η	Π	β	@

<b>k = 3</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>S</b>	ρ	Σ	β	ρ	%	%	†	ç	†	†	α	Π	€	¥	Σ	β	¥	€	α	⊕	α	α	Φ	¥	Φ	ç	†	⊕	Π
<b>A</b>	⊕	α	†	α	μ	Ξ	⊖	μ	Λ	Λ	†	α	Ω	Ω	β	†	Ψ	Ψ	†	#	@	#	α	¥	β	Ξ	⊖	@	⊕
<b>C</b>	ç	ρ	α	%	♥	♦	#	♦	#	@	⊕	ç	η	ε	Π	⊕	η	ε	α	Ξ	Ξ	μ	Π	¥	ρ	♥	@	μ	%

<b>k = 4</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>S</b>	ç	ρ	Ξ	μ	#	⊕	#	@	Φ	†	β	Ψ	Γ	†	Λ	α	ρ	Δ	♥	¶	%	Ξ	†	♥	Ω	♥	ρ	#
<b>A</b>	¥	@	#	Γ	Φ	⊕	¥	Δ	ç	♥	♥	ç	Λ	Ψ	ε	β	Ξ	♥	α	⊖	Δ	€	ç	Δ	♦	¶	¥	α
<b>C</b>	§	@	β	ε	†	Π	Λ	§	Λ	€	ρ	α	α	Δ	Λ	Σ	Δ	¶	§	β	ρ	¥	Ψ	♦	Δ	⊖	β	♥
<b>D</b>	♦	Π	†	Λ	ε	ρ	†	μ	@	#	Ψ	ε	%	Σ	η	Σ	α	ε	†	€	¶	Ξ	♦	Δ	Ξ	Ξ	Σ	ç

<b>k</b>	<b>=</b>	<b>5</b>																															
	<b>S</b>	<b>A</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	
						@	ε	Π	§	♥	Γ	Ψ	♥	¥	ρ	⊖	¥	ç	α	η	α	⊖	¥	Σ	Ψ	§	†	η	Γ	⊖	@	β	μ
						†	Γ	Σ	Ψ	¥	ç	♥	¶	Ψ	Λ	†	¶	%	Ξ	Γ	ç	¥	⊖	Δ	Λ	η	Σ	†	Γ	§	μ	#	†
						€	⊖	μ	Φ	†	§	¥	Λ	Δ	Σ	§	@	€	Λ	β	η	Ω	Δ	⊕	♥	%	μ	Λ	#	⊕	Λ	ρ	Λ

<b>k = 6</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>		
	Δ	#	α	Ξ	μ	€	Ω	Λ	β	⊕	α	Ξ	Σ	€	ε	€	Φ	Δ	¥	Σ	Ω	ç	Ξ	¶	†	¥		
	⊖	Λ	§	α	#	⊖	⊕	†	Φ	⊕	ç	§	Ω	Ω	Ψ	%	ç	♥	¶	€	♦	Ψ	♥	⊖	Ω	Ψ		
	β	Ω	†	η	η	@	α	Π	Λ	ç	%	ç	€	#	⊖	¥	ç	⊖	@	η	†	⊖	¥	€	§	Ψ		
	α	†	Δ	@	⊕	Ψ	Φ	μ	Ξ	♥	Λ	α	¥	⊖	¥	%	€	¥	α	β	♥	♦	⊕	@	Ξ	€		
	€	#	†	¥	Ξ	Π	Φ	β	α	€	¥	ε	Ψ	ç	Σ	♦	%	η	%	ρ	Σ	¥	†	¥	†	Λ	Φ	⊕
	†	β	†	ε	ρ	Ψ	Ω	€	ρ	§	μ	Σ	ç	Λ	Ω	ρ	Π	¥	†	¥	Σ	¥	†	Λ	Φ	⊕		

<b>k</b>	<b>=</b>	<b>7</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
	<b>S</b>		ç	Σ	€	Γ	β	¥	§	¥	β	†	†	†	€	♥	Σ	Γ	ε	§	α	♥	ε	†	ç	α	
	<b>A</b>		♦	†	Π	⊕	¥	§	¥	α	¥	♦	%	ç	¥	Ψ	ρ	ε	η	†	β	α	Σ	Δ	⊖	α	†
	<b>C</b>		#	♦	%	†	♦	α	α	Ψ	Ψ	¶	†	†	€	η	♦	ρ	⊕	⊖	Λ	§	Σ	μ	ç	¥	ρ
	<b>D</b>		¥	†	€	Φ	α	Γ	@	α	⊖	η	⊖	Λ	€	Ξ	⊖	η	Ω	Λ	Ψ	α	†	¥	Λ	¶	¥
	<b>E</b>		Λ	η	⊕	η	α	Λ	Ω	#	†	♥	♥	♦	⊖	€	⊖	⊖	†	@	β	η	†	Σ	ç	ε	%
	<b>F</b>		⊖	Π	¥	Δ	β	ç	Ξ	#	†	♦	η	ε	♥	α	Σ	β	⊕	♥	⊕	α	§	β	α	η	Ω
	<b>G</b>		⊕	†	¥	Ξ	Γ	Ω	Π	Ψ	β	η	Δ	Γ	†	Δ	@	⊖	⊖	Ω	¶	†	α	#	⊕	Ξ	Ξ

<b>k = 8</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>P</b>	<b>Q</b>	<b>R</b>	<b>T</b>	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>S</b>	μ	%	β	†	ρ	μ	%	Ψ	Π	♦	Λ	ε	§	†	β	Δ	Γ	α	¥	♦	¥	Γ	Ξ	α
<b>A</b>	⊕	⊕	Σ	⊕	Δ	μ	§	α	ρ	¥	⊖	Π	¥	†	%	#	†	¥	♥	†	@	#	ρ	¥
<b>C</b>	μ	†	¥	α	Σ	Γ	β	Σ	η	Σ	¥	Δ	Λ	Φ	¶	§	α	¶	β	Ξ	Ω	ρ	§	Γ
<b>D</b>	Δ	ç	@	Ω	¥	Ω	β	¶	ρ	€	Π	¥	♦	♥	¥	⊖	@	Φ	Ω	β	Ξ	Γ	Λ	μ
<b>E</b>	¥	Ξ	Γ	Ω	ε	μ	†	μ	@	§	Λ	η	Ξ	%	€	ε	Σ	α	€	Ξ	⊕	⊕	¥	β
<b>F</b>	α	ε	†	⊖	⊖	#	†	⊕	§	Λ	η	Ξ	%	€	ε	Σ	α	€	Ξ	⊕	⊕	⊕	⊕	†
<b>G</b>	¥	ρ	¶	μ	ρ	Σ	Λ	§	Ξ	⊖	α	α	Γ	¥	¥	¥	β	Ψ	♥	Ξ	Δ	⊖	#	♦
<b>H</b>	♥	α	¶	Λ	@	β	¥	Γ	μ	♥	Δ	¥	ç	ε	Ω	⊕	†	♥	#	⊕	¶	ρ	%	Ξ