Yamaha DX7 to Yamaha SY77 Conversion Guide

Summary

This document describes how to convert Yamaha DX7 and DX7II Voices and DX7II Performances to the Yamaha SY77/TG77/SY99 series of synthesizers.

The guide is useful for people either wishing to manually convert Voices or to write programming utilities to do so. For example, my sy.factory librarian has this capability.

Contents

Introduction

This document describes how to convert Yamaha DX7 and DX7II Voices and DX7II Performances to the Yamaha SY77/TG77/SY99 series of synthesizers. Where I refer to either SY77 or SY I of course mean SY77, TG77 or SY99.

The guide is useful for people either wishing to manually convert Voices or to write programming utilities to do so. For example, my sy.factory librarian has this capability.

The contents of this document are the results of my own investigations into the differences between the DX and SY series. My work may or may not be 100% correct, and I also guess there are different approaches as well to the conversion that may yield similar or better results. Feel free to offer improvement suggestions via the support page on my website listed above.

Like any conversion where the Voice Architectures are different, perfect conversion results cannot be guaranteed.

While the SY77 is very obviously based on the DX7 6 Operator implementation, it is quite different in a number of areas, the key ones being:

- There are 45 algorithms on the SY77, and a mapping between DX7 and SY77 algorithms has to be made. This is more complicated than it sounds, as instead of setting a single algorithm value (like on the DX7) there are parameters in the operators that need to be carefully setup that define how they work within the algorithm as the SY77 has a more complex FM implementation (e.g., multiple and programmable feedback paths).
    - If you are doing a manual conversion then the SY will set a lot of this up for you when selecting the correct algorithm, however a program utility needs to set up a lot of parameters (including "internal parameters" not referenced in the SY MIDI implementation.
- When selecting a suitable SY77 algorithm, the mapping of operators between the DX7 algorithm is not always a 1 to 1 relationship. For example, DX7 algorithm 7 maps to SY77 algorithm 32, and operator 6 maps to operator 5, operator 5 to operator 4, operator 5 to operator 6, with the remaining operators mapping 1 to 1.
- A lot of parameters have either a more limited or greater range on the SY77, so DX7 values need to be scaled to match the SY77 range.
- The envelopes on the SY77 have more segments.
- The big difference between the DX7 and SY77 is operator level scaling. On the DX7 you program a single breakpoint (key value) and then a depth and curve type (exponential or linear) either side of the breakpoint. On the SY77 you have four breakpoints and a level for each one. So, this is where the biggest difference in sound occurs as the scaling can only be approximated. This may result in voices being brighter or duller in tone (for scaling on a modulating operator) or volume (for scaling on a carrier operator) than the source DX7 Voice.

References

- DX7 Owner's Manual
- DX7II Owner's Manual
- SY Programming by Herbert Janssen

SY77 Voice Common Parameters mapped from the DX7/DX7II

DX7 and DX7II common voice parameters that need mapping to an SY Voice

Note 1: Some DX7 Parameters are global "function parameters" and not included in the Voices themselves, and thus unavailable.
Note 2: DX7/DX7II parameter names are from the DX7II manual; the DX7 manual does not provide shortform names.

SY77		**DX7**		
Parameter	**Name**	**Parameter**	**Name**	**Notes**
ELMODE	Element Mode	DX7: --------- DX7II: PMOD DX7II: PLMD	DX7: ---------- DX7II: Voice Mode DX7II: Performance Mode	Needs to be set according to the following 1 AFM Poly for DX7 voices or DX7II single performance (using only Voice A) 2 AFM Poly for a DX7II dual/split performance (using both Voice A and Voice B) 1 AFM Mono if PMOD bit 0 is set for DX7II Voices or single performance The DX7 Poly/Mono mode is a Function Parameter, not stored in a Voice The DX7II Unison mode is not supported on the SY77 The DX7II can also mix and match different modes, but an SY77 cannot.
VNAME0	Voice Name Character 0	VNAM1	Voice Name Character 1	Or truncated Performance name for DX7II Performances
to				
VNAME9	Voice Name Character 9	VNAM10	Voice Name Character 10	
WPBR	Wheel Pitch Bend Range	DX7II: PBR		DX7: Function parameter in DX7. Leave at SY77 default DX7II: Direct mapping from PBR
ATPBR	After Touch Pitch Bend Range			DX7: Leave at SY77 default DX7II: Leave at SY77 default
PMASN	Pitch Modulation Device Assign			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
PMRNG	Pitch Modulation Range			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
AMASN	Amplitude Modulation Device Assign			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
AMRNG	Amplitude Modulation Range			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
FMASN	Filter Modulation Device Assign			DX7: Leave at SY77 default DX7II: Leave at SY77 default
FMRNG	Filter Modulation Range			DX7: Leave at SY77 default DX7II: Leave at SY77 default
PNLASN	Pan Modulation Device Assign			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
PNLRNG	Pan Modulation Range			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
COASN	Filter Cutoff Bias Device Assign			DX7: Leave at SY77 default DX7II: Leave at SY77 default

SY77		DX7		
CORNG	Filter Cutoff Bias Range			DX7: Leave at SY77 default DX7II: Leave at SY77 default
PNBASN	Pan Bias Device Assign			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
PNBRNG	Pan Bias Range			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
EGBASN	EG Bias Device Assign			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
EGBRNG	EG Bias Range			DX7: Leave at SY77 default DX7II: Consider preference selection for DX7II MW, FC1, BC, AT, FC2, MC
VVLASN	Voice Volume Device Assign			DX7: Leave at SY77 default DX7II: Leave at SY77 default
VVLLML	Volume Limit Low			DX7: Leave at SY77 default DX7II: Leave at SY77 default
MCTUN	Microtuning Table Select	MCTB MCKY	Microtuning Table Select Microtuning Key	**DX7**: **DX7II Voice:** Set to 2 (normal tuning, 0-1 = user microtunings, 2+ = preset mictotunings) **DX7II Performance** There are 11 preset microtunings in the DX7II. These correspond with Microtunings 1 to 55 in the SY77. The Combination of MCTB and MCKY will need to be used to select the appropriate SY77 microtuning.
RNDP	Random Pitch Fluctuation	RNDP	Random Pitch Fluctuation	**DX7**: Set to 0. **DX7II** Only if DX7II ACED data is available, otherwise defaults to 0
PORM	Portamento Mode	PORM	Portamento Mode	DX7II Only; function parameter on DX7. Need to check bits in PORM and see what they do. Set to 1 for DX7 Voices
POS	Portamento Time	POS	Portamento Time	DX7II Only; function parameter on DX7. Needs scaling from **0~99** to **0~127** Set to 0 for DX7 Voices
VVOL	Voice Volume	TVLM	Total Volume	DX7/DX7II Voices set to 127 DX7II Performance only set to TVLM

SY77 Normal Voice Element Data Mapped from the DX7/DX7II

DX7 and DX7II common voice parameters that need mapping to an SY Element within an SY voice. A DX7/DX7II Voice or a DX7II Performance can be mapped to an SY **1 AFM Poly** Voice type which has a single AFM element.

A DX7II split or layered Performance requires an SY **2 AFM Poly** Voice type, which has two AFM elements and the DX7II Performance Voice A is mapped into Element 1, and the DX7II Performance Voice B is mapped into Element 2.

For SYSEX Dumps that contain DX7II Performance and Voice data you need to decide if you are converting Voices, Performances or Voices and Performances. If DX7II performance data is detected, my sy.factory librarian creates two JNN files: One for the Voices and one for the Performances.

Note 1: DX7/DX7II parameter names are from the DX7II manual; the DX7 manual does not provide shortform names.

SY77		**DX7/DX7II**		
Parameter	**Name**	**Parameter**	**Name**	**Notes**
ELVL	Element Level	DX7: ----- DX7II: BLNC	DX7: ----- DX7II: BLNC	DX7: Set to 127 for DX7 Voices. DX7II: For DX7 II Dual/Split Performances the BLNC parameter should be used to scale the relative volume of the two elements. BLNC = -50 = only Element 1 should sound. BLNC = +50 = only Element 2 should sound.
ELDT	Element Detune	DDTN	Dual Detune	**DX7II Performance only**. Element 1 = +DDTN. Element 2 = -DDTN. On the SY77 this is a four bit field, with the MSB being a sign bit, which is set for negative values. E.g. 0x00 = 0 0x01 = +1, 0x07 = +7 0x09 = -1, 0x0f = -7
ELNS	Element Note Shift	DX7: TRNP DX7II: NSFTA DX7II: NSFTB	Transpose Note Shift A Note Shift B	DX7: Transpose is +/- 2 octaves, so centre Range is 0x18. SY centre Range is 0x40, so add 0x28 to DX7 Value DX7II: Add or subtract DX7II Performance Note shift from DX7 Voice Transpose. The combination of a DX7 TRNP and DX7II NSFT is up to four octaves. The SY77 note shift is greater than plus or minus five octaves.
ENLL	Element Note Limit Low	SPPT	Split Point	**DX7II Performance only**. For DX7 Voice or DX7II Dual Performance, set to 0 For DX7II Split Performance, Element 1 is set to 0, Element 1 is set to SPPT+1
ENLH	Element Note Limit High	SPPT	Split Point	**DX7II Performance only**.

				For DX7 Voice or DX7II Dual Performance, set to 127 For DX7II Split Performance, Element 1 is set to SPPT, Element 1 is set to 127
EVLL	Element Velocity Limit Low	-----	-----	Default to 1
ELVH	Element Velocity Limit High	-----	-----	Default to 127
PANNM	Pan data set table select	-----	-----	Set to 32 (0x20), default preset pan
MCTEN	Micro Tuning Switch	MCSW	Microtuning Switch (A/B)	**DX7II only**. Bit 0 is Voice A (Element 1). Bit 1 is Voice B (Element 2) For DX7, set to 0.
OUTSEL0	Output Select 1	-----	-----	Set to 1
OUTSEL1	Output Select 2	-----	-----	Set to 1

SY77 AFM Element Common Parameters mapped from the DX7/DX7II

DX7 and DX7II common element parameters that need mapping to an SY Element within an SY voice. A DX7/DX7II Voice or a DX7II Performance can be mapped to an SY **1 AFM Poly** Voice type which has a single AFM element.

A DX7II split or layered Performance requires an SY **2 AFM Poly** Voice type, which has two AFM elements and the DX7II Performance Voice A is mapped into Element 1, and the DX7II Performance Voice B is mapped into Element 2.

For SYSEX Dumps that contain DX7II Performance and Voice data you need to decide if you are converting Voices, Performances or Voices and Performances. If DX7II performance data is detected, my sy.factory librarian creates two JNN files: One for the Voices and one for the Performances.

Note 1: DX7/DX7II parameter names are from the DX7II manual; the DX7 manual does not provide shortform names.

SY77		**DX7**		
Parameter	**Name**	**Parameter**	**Name**	**Notes**
ALGNUM	Algorithm Number	ALS	Algorithm Selector	Lookup table required to map from DX7 to SY7. See the algorithm mapping later in this document in Section **DX7 to SY77 Algorithm Mapping – Algorithm** Selection on Page 16. The operators also need to be remapped to match the algorithm. See the translation table given in Section **DX7 to SY77 Algorithm Mapping – Operator Remapping and Values** on Page 33. There may of course be other possibilities for operator reuse, but these are the ones I selected for sy.factory.
FPR1	Pitch EG Key On Rate 1	PR1	Pitch EG Rate 1	Needs scaling from **0 ~ 99** to **0 ~ 63**
FPR2	Pitch EG Key On Rate 2	PR2	Pitch EG Rate 2	Needs scaling from **0 ~ 99** to **0 ~ 63**
FPR3	Pitch EG Key On Rate 3	PR3	Pitch EG Rate 3	Needs scaling from **0 ~ 99** to **0 ~ 63**
FPRR1	Pitch EG Key Off Release Rate 1	PR4	Pitch EG Rate 4	Needs scaling from **0 ~ 99** to **0 ~ 63**
FPL0	Pitch EG Key On Level 0	PL4	Pitch EG Level 4	Needs scaling from **-50 ~ +49** to **-64 ~ +63** Note that PL4 is used for both FPL0 and FPRL1
FPL1	Pitch EG Key On Level 1	PL1	Pitch EG Level 1	Needs scaling from **-50 ~ +49** to **-64 ~ +63**
FPL2	Pitch EG Key On Level 2	PL2	Pitch EG Level 2	Needs scaling from **-50 ~ +49** to **-64 ~ +63**
FPL3	Pitch EG Key On Level 3	PL3	Pitch EG Level 3	Needs scaling from **-50 ~ +49** to **-64 ~ +63**
FPRL1	Pitch EG Key Off Level 1	PL4	Pitch EG Level 4	Needs scaling from **-50 ~ +49** to **-64 ~ +63** Note that PL4 is used for both FPL0 and FPRL1
FPEGR	Pitch EG Range	DX7II PBR		DX7: Set to 0 DX7II: Direct 1 to 1 transfer

SY77		DX7		
FPRS	Pitch EG Rate Scaling	DX7II PGRS		DX7: Set to 0 DX7II: Direct 1 to 1 transfer Translate from **0 ~ 7** to **-7 ~ +7**. This is a direct one to one mapping, as on the SY99 this is a four bit field, with the MSB being a sign bit, which is set for negative values. E.g. 0x00 = 0 0x01 = +1, 0x07 = +7 0x09 = -1, 0x0f = -7
FVPSW	Pitch EG Velocity Switch	DX7II VPSW		DX7: Set to 0 DX7II: Direct 1 to 1 transfer
FLFSPD	LFO Speed	LFS	LFO Speed	Use scaling table
FLFDLY	LFO Delay	LFD	LFO Delay Time	Direct 1 to 1 transfer
FLFPMD	LFO Pitch Modulation Depth	LPMD	LFO Pitch Mod Depth	Translate from **0 ~ 99** to **0 ~ 127** - Simple scaling is fine
FLFAMD	LFO Amplitude Modulation Depth	LAMD	LFO Amplitude Mod Depth	Translate from **0 ~ 99** to **0 ~ 127** - Simple scaling is fine
FLFFMD	LFO Filter Modulation Depth	----	----	Set to 0x00
FLPFWAV	LFO Wave	LFW	LFO Wave	Direct 1 to 1 transfer
FLINTP	LFO Initial Phase			Set to 0x00
SLFWD	Sub LFO Wave	----	----	Set to 0
SLFS	Sub LFO Speed	----	----	Set to 80
SLFDM	Sub LFO Delay and Decay Mode	----	----	Set to 0
SLFDT	Sub LFO Delay and Decay Time	----	----	Set to 0
SLPMD	Sub LFO Pitch Modulation Depth	----	----	Set to 0.

Note: The DX7 **FBL** voice parameter is translated as an input level on the SY77 operator with the feedback path.

SY77 AFM Element Operator Parameters mapped from the DX7/DX7II

The DX7 operator parameters that need mapping to SY AFM operators.

Note: Depending on the algorithm mapping, there may not be a direct 1 to 1 mapping relationship between DX and SY operators. For example, DX7 algorithm 7 maps to SY77 algorithm 32, and operator 6 maps to operator 5, operator 5 to operator 4, operator 5 to operator 6, with the remaining operators mapping 1 to 1.

SY77		**DX7**		
Parameter	**Name**	**Parameter**	**Name**	**Notes**
R1	EG Key On Rate 1	R1		DX7 R1, scaled by (99/63) or use a lookup table
R2	EG Key On Rate 2	R2		DX7 R2, scaled by (99/63) or use a lookup table
R3	EG Key On Rate 3	R3		DX7 R3, scaled by (99/63) or use a lookup table
R4	EG Key On Rate 4	----	----	DX7 R3, scaled by (99/63) or use a lookup table
RR1	EG Key Off Rate 1	R4		DX7 R4, scaled by (99/63) or use a lookup table
RR2	EG Key Off Rate 2	----	----	DX7 R4, scaled by (99/63) or use a lookup table
L0	EG Key On Level 0	----	----	Set to 0.
L1	EG Key On Level 1	L1		DX7 L1, scaled by (99/63) or use a lookup table
L2	EG Key On Level 2	L2		DX7 L2, scaled by (99/63) or use a lookup table
L3	EG Key On Level 3	L3		DX7 L3, scaled by (99/63) or use a lookup table
L4	EG Key On Level 4	----	----	DX7 L3, scaled by (99/63) or use a lookup table Note: has no effect when R4/L4 is the same as R3/L3
RL1	EG Key Off Level 1	----	----	DX7 L4, scaled by (99/63) or use a lookup table
RL2	EG Key Off Level 2	L4		DX7 L4, scaled by (99/63) or use a lookup table Note: has no effect when R4/L4 is the same as R3/L3
SLP	EG Sustain Loop Point	----	----	Set to 3 (Loop at L4)
DT	EG Key On Hold Time	----	----	Set to 63 (0 on SY77 display is 63 – HT value)
RS	EG Rate Scaling	RS	Rate Scaling	Translate from **0 ~ 7** to **-7 ~ +7**. This is a direct one to one mapping, as on the SY99 this is a four bit field, with the MSB being a sign bit, which is set for negative values. E.g. 0x00 = 0 0x01 = +1, 0x07 = +7 0x09 = -1, 0x0f = -7
FAMS	Amplitude Modulation Sensitivity	AMS	Amplitude Modulation Sensitivity	DX7: AMS parameter in VCED. Set to Round(DX AMS × (7 ÷ 3),0), which gives: 0, 2, 5, 7 DX7II : AMS parameter in ACED data. Direct mapping

SY77		DX7		
VSON	Velocity Sensitivity	TS	Touch Sensitivity	Translate from **0 ~ 7** to **-7 ~ +7**. This is a direct one to one mapping, as on the SY99 this is a four bit field, with the MSB being a sign bit, which is set for negative values. E.g. 0x00 = 0 0x01 = +1, 0x07 = +7 0x09 = -1, 0x0f = -7
ALGSRC0	Oscillator Input Source 0	----	----	Set according to the algorithm and operator mappings using the values given in Section **DX7 to SY77 Algorithm Mapping – Operator Settings for the Different Algorithms** on Page 34.
ALGSRC1	Oscillator Input Source 1	----	----	
ALGDST	Oscillator Output Destination	----	----	
OACSRC0	Out Accumulator Input 0 Source	----	----	
OACSRC1	Out Accumulator Input 1 Source	----	----	
SHIFT0	Oscillator Input 0 Shift Value	----	----	
SHIFT1	Oscillator Input 1 Shift Value	----	----	
COR	Output Level Correction	----	----	
PWAVE	Oscillator Waveform	----	----	Set to 0 (sinewave)
FMLPMS	Main LFO Pitch Modulation Sensitivity	LPMS	LFO Pitch Mod Sensitivity	This is a voice parameter applied to all operators in the DX7, so apply that DX7 voice parameter to all SY77 operators Direct mapping between DX7 and SY77
PES	Pitch EG Switch	VPSW		DX7, set to 1 DX7II, set all SY77 values to value of VPSW
FPM	Frequency Mode	PM	Frequency Mode	This is a direct copy between DX7 and SY77. 0 = Ratio, 1 = Fixed
KOE	Initial Phase Set Enable	OPI	Oscillator Phase Init	Direct mapping between DX7 and SY77 Note, this is a voice parameter in the DX7, but can be independently set on each SY77 oscillator. Apply the DX7 setting to all operators
PHASE	Initial Phase of Oscillator	-----	-----	Set to 0
FPD	Pitch Detune	PD	Detune	Translate from **-7 ~ 7** to **-15 ~ +15** Note, DX7 0 setting is 0x07. SY77 0 setting is 0x00, with B4 being a sign bit. So will need to translate. Translation table may be easiest Simple translation table is [23, 22, 21, 20, 19, 18, 17, 0, 1, 2, 3, 4, 5, 6, 7]
TL	Total Level	TL	Total Level	Translate from **0 ~ 99** to **0 ~ 127** DX7 TL × (127 ÷ 99), or use the table in Section 9.6 of the SY Programming Guide. They say that mapping is nonlinear and best provided by a lookup table.

SY77		DX7		
BP1	Output Scaling Break Point 1	----		Note that BP1-4 and EGOS1-4 are the most difficult parameters to translate from the DX to the SY as the output scaling approaches are totally different. This is the best approximation I could come up with. 21
BP2	Output Scaling Break Point 2	BP	----	21 + DX7 BP Value
BP3	Output Scaling Break Point 3	----	----	120 (21 + 99)
BP4	Output Scaling Break Point 3	----	----	127
EGOS1	Output Level Scaling Offset BP1	LD, LC		DX7 LD × (127 ÷ 99), inverting LD if LC is –LIN or -EXP
EGOS2	Output Level Scaling Offset BP2	----	----	0
EGOS3	Output Level Scaling Offset BP3	RD, RC		DX7 RD × (127 ÷ 99), inverting RD if RC is –LIN or -EXP
EGOS4	Output Level Scaling Offset BP4	----	----	Set the same as the EGOS3 value
RVSW	Rate Velocity Switch			Set to 1
FPC	Frequency Course	PC	Frequency Coarse	If frequency mode is 0 (Ratio), then this is a direct mapping. If frequency mode is 1 (Fixed), then add 1 to the value. This is because The DX7 value is from 0-3 (1,10,100,1000), and the SY77 value is from 0-4 (0,1,10,100,1000). Note, it may be possible that the DX7 allows values greater than 3 when the mode is fixed. If so, take the modulus of the frequency coarse value (4 % frequency coarse).
FPS	Frequency Fine	PF	Frequency Fine	Direct mapping Taking the fixed frequency values as an example, the DX7 and DX7 II fixed frequency values are a little different, but no great than 1% difference, and there would be more error in rounding up or donw to the next value.

DX7II Performance Parameters Mapped to the SY77

If DX7II Performance data is detected in a SYSEX file then it can either be ignored or you use the data to create the SY Voice equivalent of a DX7II performance. DX7II Performances reference the DX7II Voices only by number, so multiple performances can reference the same Voice. However, this is not possible in the SY, so the best approach if Voice and Performance data is detected in a DX7II SYSEX file is to:

- Create an SY JNN file for the Voices
- Create an SY JNN file for the Performances (with the DX7II two Voices incorporated into the SY77 Voice as separate AFM elements)

DX7II		**SY77**	
Parameter	**Notes**	**Parameter**	**Notes**
VNMA	A Channel Voice Number	----	Use to select the Voice for Element 1 conversion
VNMB	B Channel Voice Number	----	Use to select the Voice for Element 2 conversion
PNMD	Pan Mode	----	Create PAN Settings for each DX7II Performance Use to select whether or not an element has its pan table set. Also • Set the Pan Name to the Performance Name • Set the PAN EG Loop Point to 3
PANRNG	Pan Controller Range	PNSCDPT	Direct Mapping
PANASN	Pan Controller Assign	PNSCSEL	Map from DX7II LFO, Velocity Key To SY77 Velocity, Key, LFO
PNEGR1	Pan EG Rate 1	PNR1	Map from 0-99 to 0-63
PNEGR2	Pan EG Rate 2	PNR2	Map from 0-99 to 0-63
PNEGR3	Pan EG Rate 3	PNR3 PNR4	Map from 0-99 to 0-63
PNEGR4	Pan EG Rate 4	PNRR1 PNRR2	Map from 0-99 to 0-63
PNEGL1	Pan EG Level 1	PNL1	
PNEGL2	Pan EG Level 2	PNL2	
PNEGL3	Pan EG Level 3	PNL3 PNL4	
PNEGL4	Pan EG Level 4	PNL0 PNRL1 PNRL2	

DX7 Voice Parameters not Mapped to SY77

The following DX7 Voice parameters are ignored by sy.factory during conversion as I could not find equivalents in the SY, but I did write the converter a decade ago! If you know otherwise then please let me know.

DX7		SY77	
Parameter	**Notes**	**Parameter**	**Notes**
LFKS	LFO Key Sync		I don't think that LFO Key Sync is supported on the SY77. It's pretty unnatural anyway!

DX7II Voice Parameters not Mapped to SY77

The following DX7II Voice parameters are ignored by sy.factory during conversion as I could not find equivalents in the SY, but I did write the converter a decade ago! If you know otherwise then please let me know.

DX7II		SY77	
Parameter	**Notes**	**Parameter**	**Notes**
LTRG	LFO Key Trigger Delay		
PBS	Pitch Bend Step		
PBM	Pitch Bend Mode		
PONT	Portamento Step		Unused. I think this is used to create Glissandos on the DX7II
----	Reserved		
UDTN	Unison Detune Depth		Unused, as the SY77 does not support unison mode?
FCCS1	Use FC 1 as CS1 switch		

DX7II Operator Parameters not Mapped into SY77

The following DX7II Operator parameters are ignored by sy.factory during conversion as I could not find equivalents in the SY, but I did write the converter a decade ago! If you know otherwise then please let me know.

DX7II		SY77	
Parameter	**Notes**	**Parameter**	**Notes**
SCM 6	OP6 Scaling Mode		Fractional scaling not supported on SY77.
SCM 5	OP5 Scaling Mode		Fractional scaling not supported on SY77.
SCM 4	OP4 Scaling Mode		Fractional scaling not supported on SY77.
SCM 3	OP3 Scaling Mode		Fractional scaling not supported on SY77.
SCM 2	OP2 Scaling Mode		Fractional scaling not supported on SY77.
SCM 1	OP1 Scaling Mode		Fractional scaling not supported on SY77.

DX7II Performance Parameters not Mapped into SY77

The following DX7II Performance parameters are ignored by sy.factory during conversion as I could not find equivalents in the SY, but I did write the converter a decade ago! If you know otherwise then please let me know.

DX7II		**SY77**	
Parameter	**Notes**	**Parameter**	**Notes**
FDMP	EG Forced Damping		
SPSW	Sustain Foot Switch		Utility Parameter on SY77
FSAS	Foot Switch Assign		
FSW	Foot Switch Range		
CSLD1	Continuous Slider 1		
CSLD2	Continuous Slider 2		

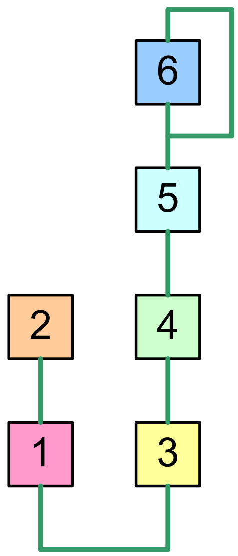
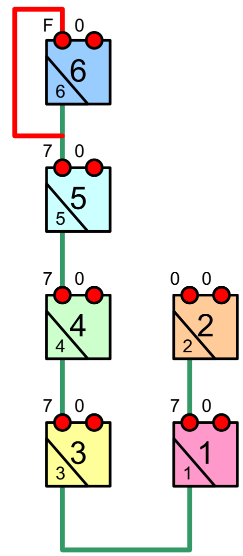
DX7 to SY77 Algorithm Mapping – Algorithm Selection

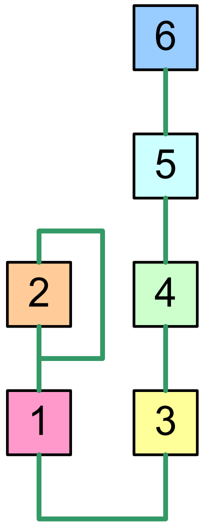
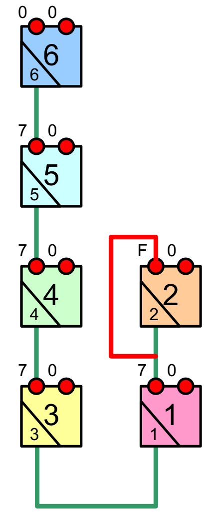
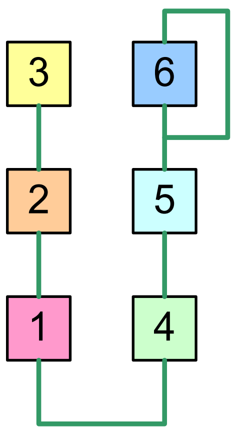
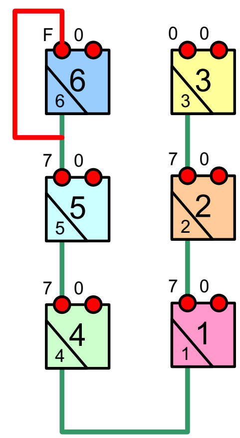
The following table provides the mapping of DX7 algorithms to SY77 algorithms.

The operators are colour coded so that you can visually see the mapping of DX7 to SY77 operators, as it is not always a one to one mapping.

On the SY77 diagrams:

- The number in the triangle in the lower left corner is the DX7 operator number. On a one to one mapping the number will be the same as the SY77 operator number, but where a mapping has been required then the numbers will be different
- Each operator has two inputs
- Only a few SY77 algorithms have hardwired feedback. A red line shows a feedback loop that needs to be programmed within an algorithm where the feedback is not hardwired.
- Each input on the SY77 shows the programmed input value required: either 7 or 0, or in the case of the operator with a feedback input then "F" refers to the actual feedback level (FBL) in the DX7 patch.
- On the more complex SY77 algorithms, such as 43, the equivalent DX7 patch is made by the programming of the input levels, specifically setting the input level to 7, where a connection is required, or 0 where a connection is not required.

DX7		SY77	
1		30	

DX7		SY77	
2		30	
3		34	

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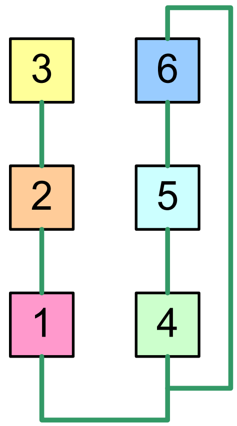
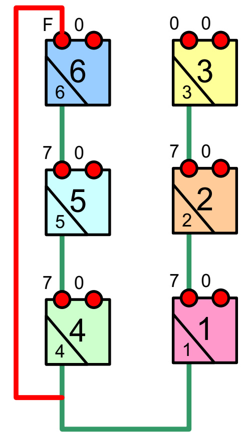
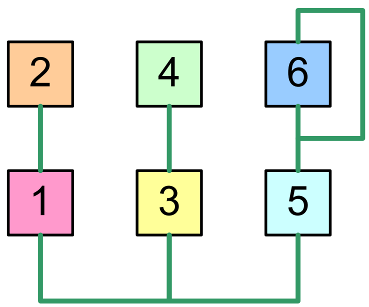
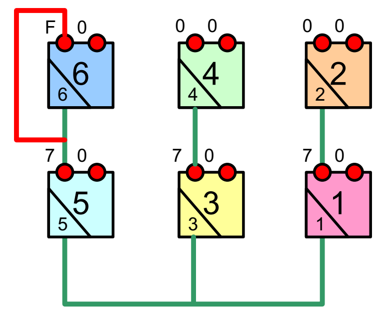
4		34	
5		42	

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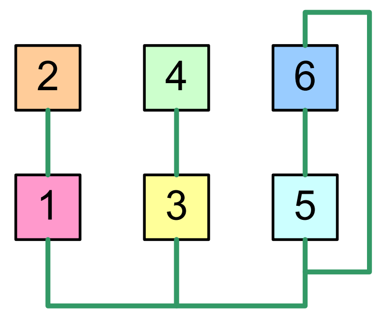
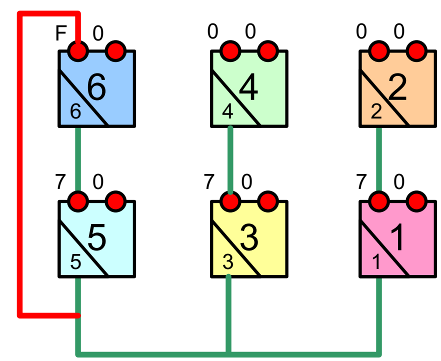
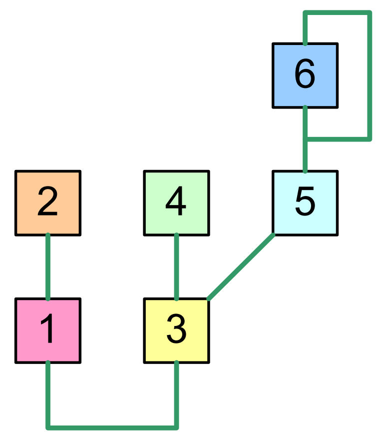
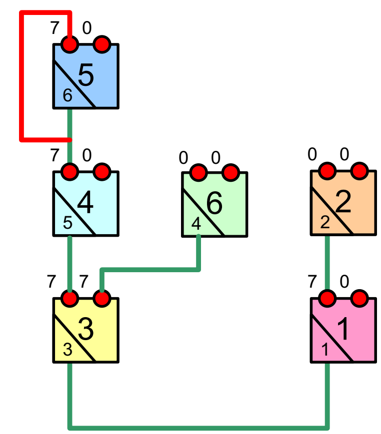
6		42	
7		32	

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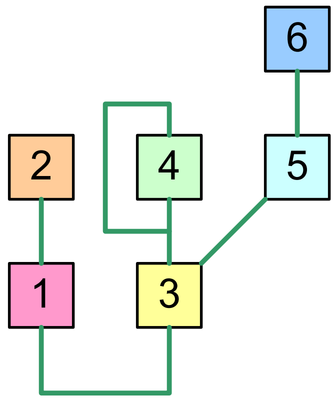
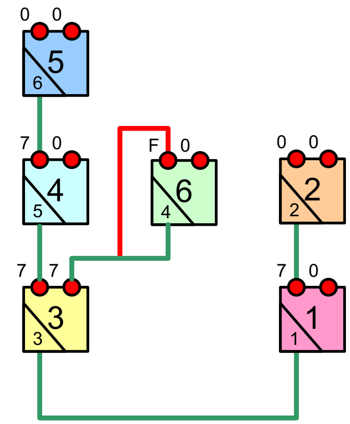
<tr><td>8</td><td>
</td><td>32</td><td>
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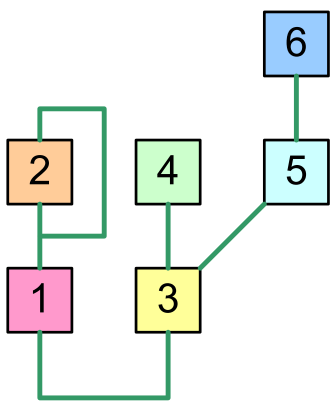
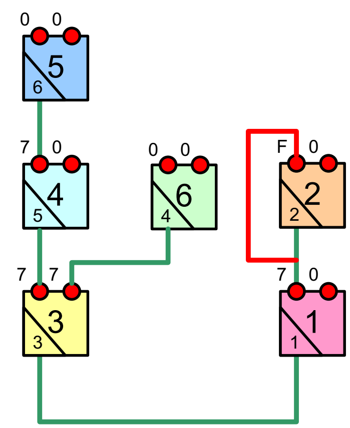
<tr><td>9</td><td>
</td><td>32</td><td>
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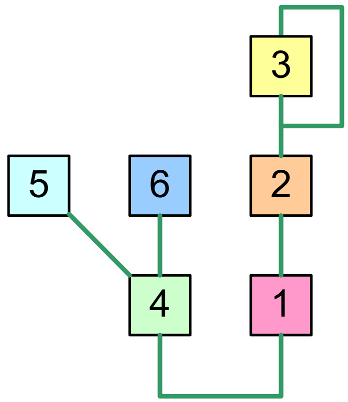
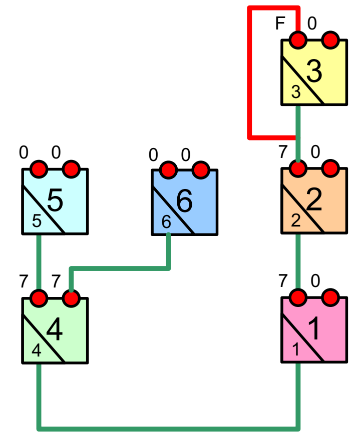
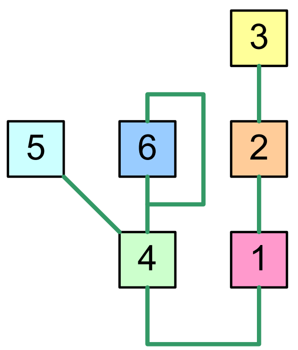
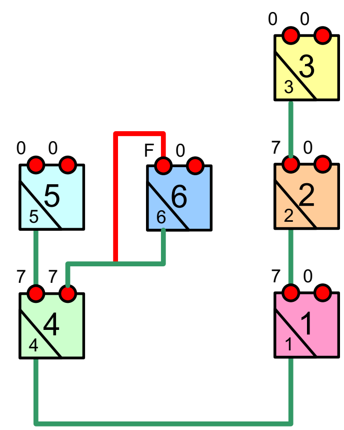
10		35	
11		35	

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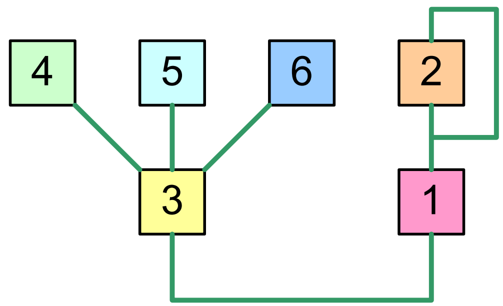
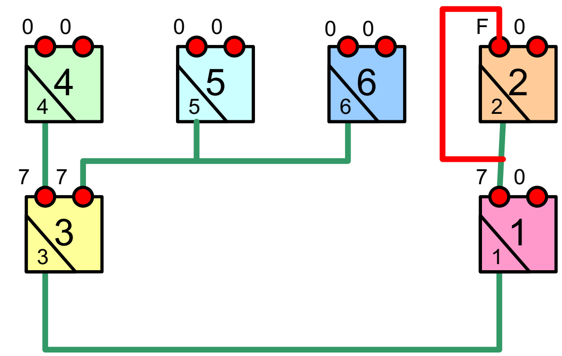
<tr><td>12</td><td>
</td><td>33</td><td>
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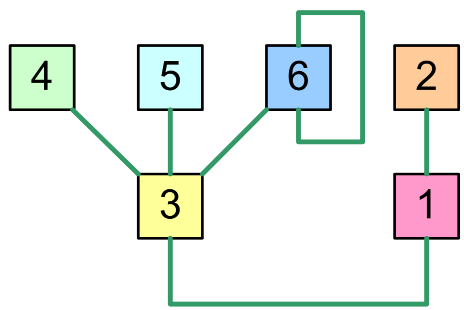
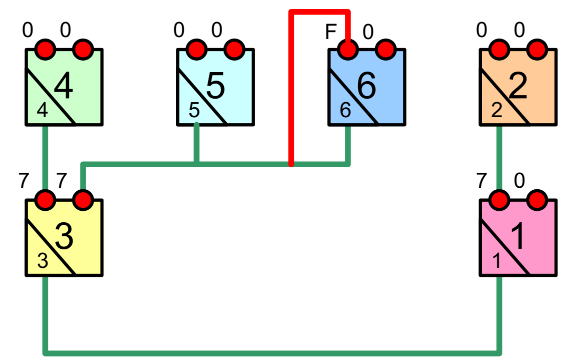
<tr><td>13</td><td>
</td><td>33</td><td>
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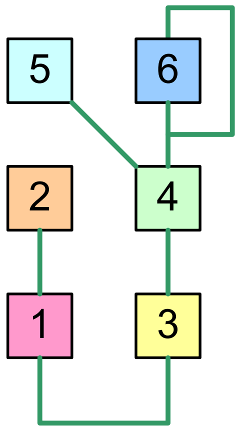
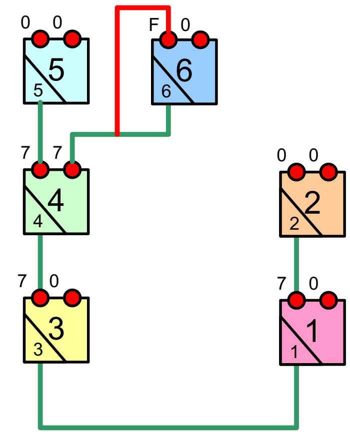
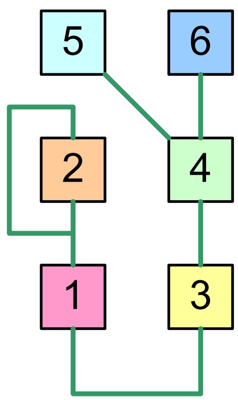
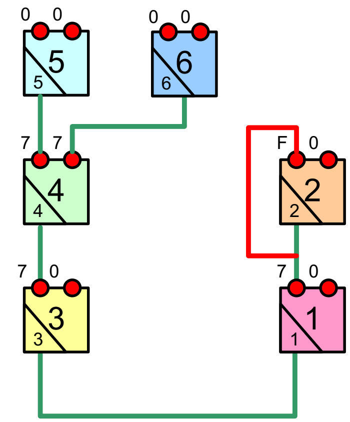
14		31	
15		31	

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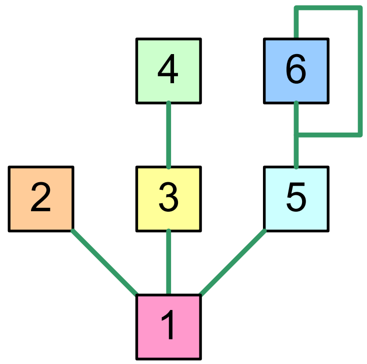
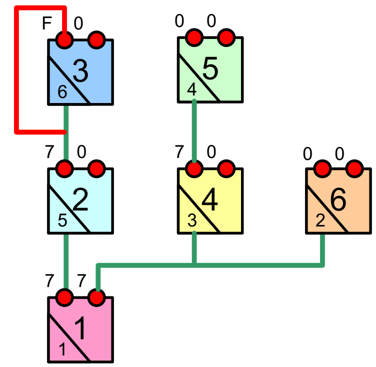
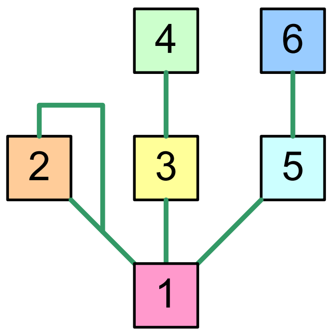
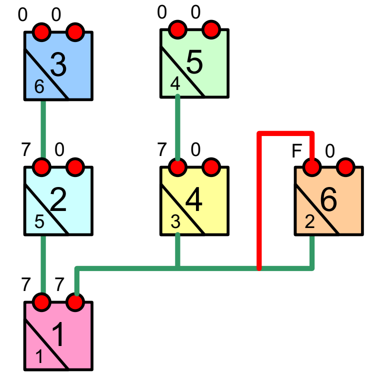
16		16	
17		16	

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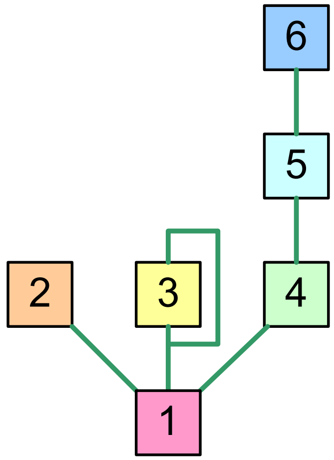
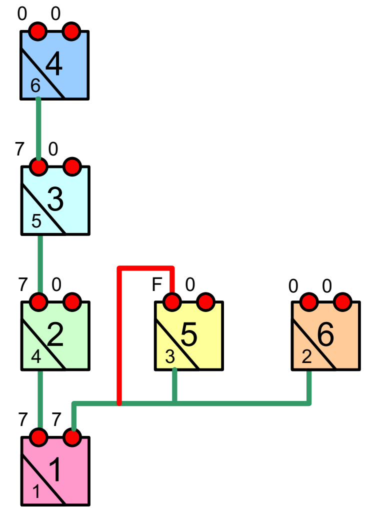
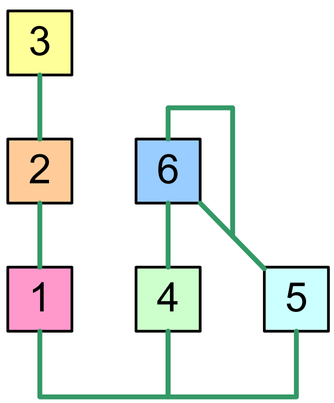
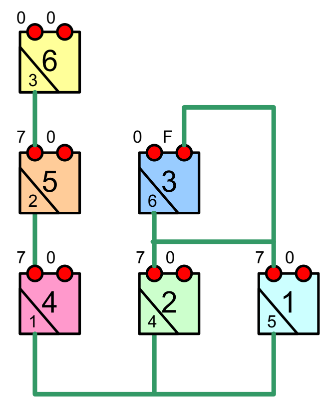
18		11	
19		40	

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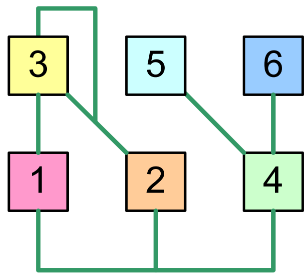
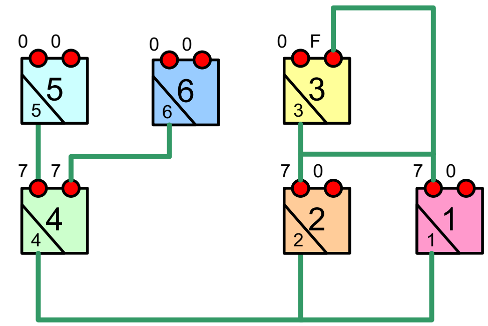
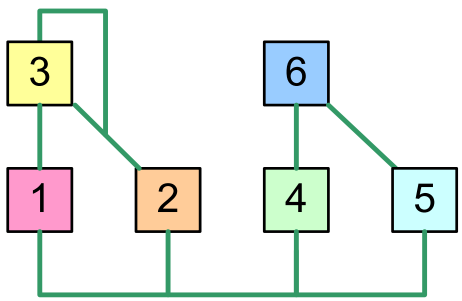
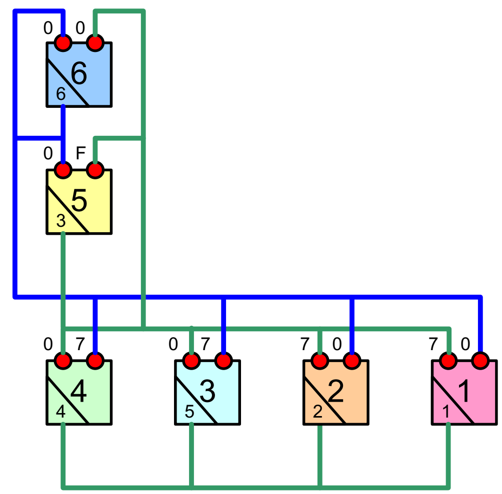
20		41	
21		43	

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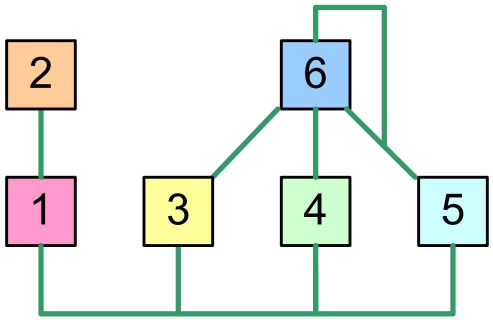
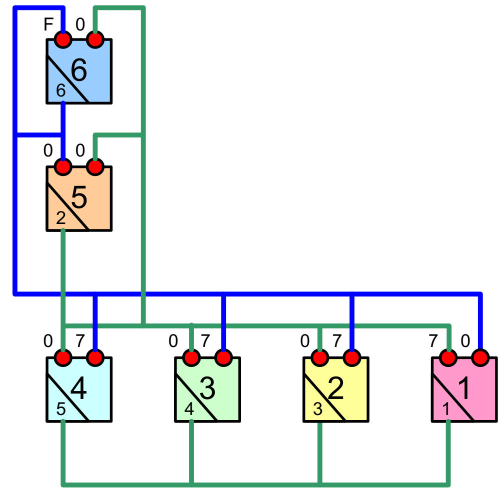
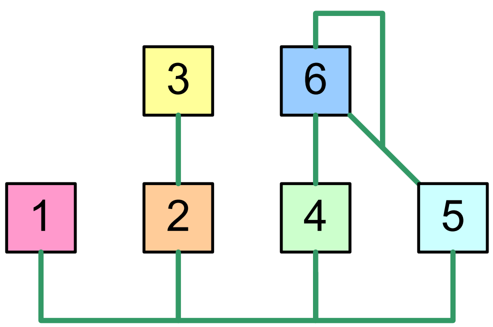
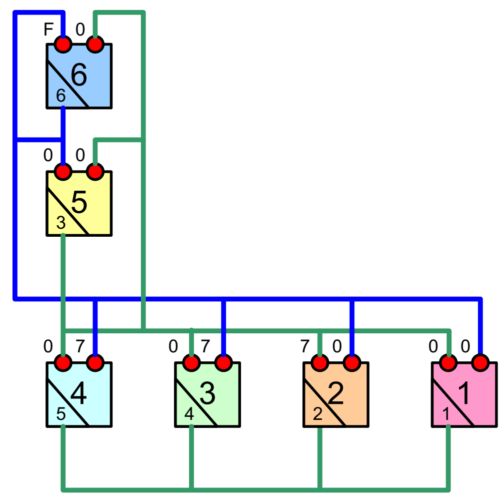
22		43	
23		43	

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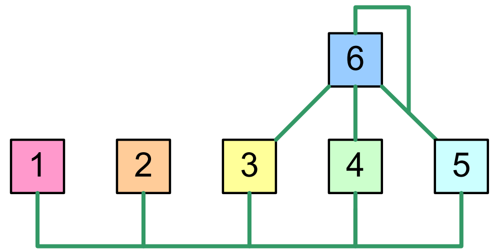
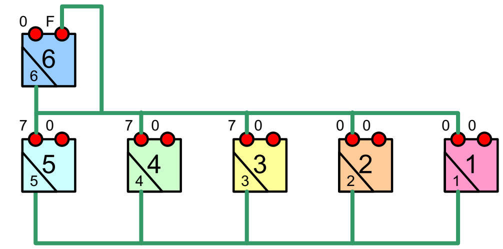
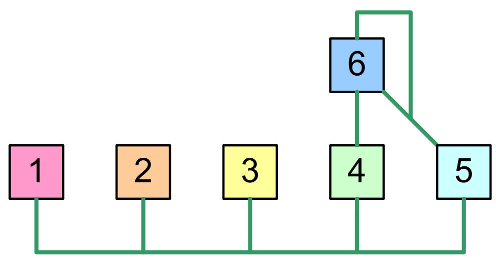
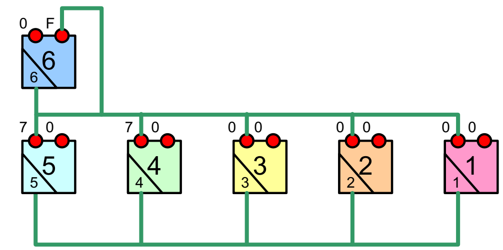
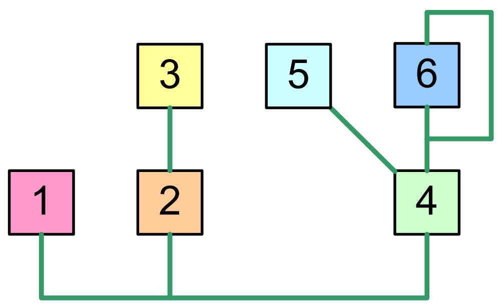
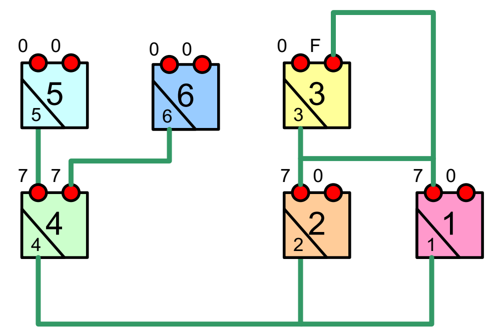
24		44	
25		44	
26		41	

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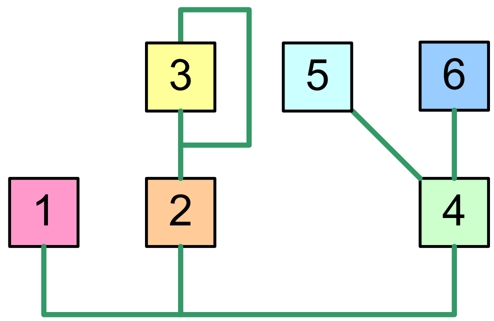
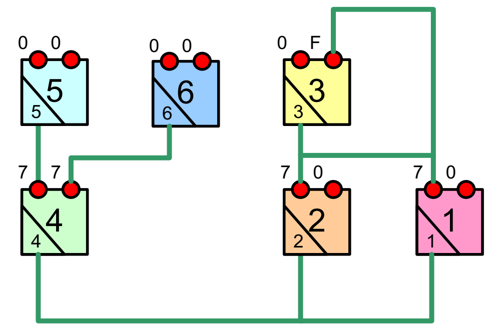
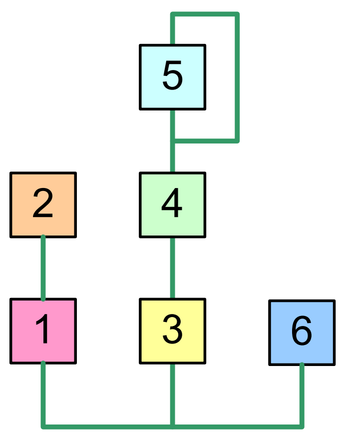
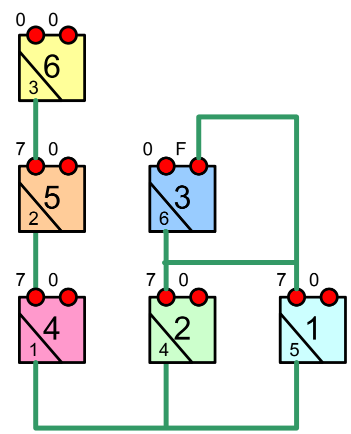
27		41	
28		40	

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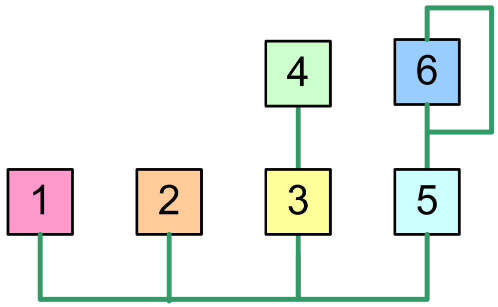
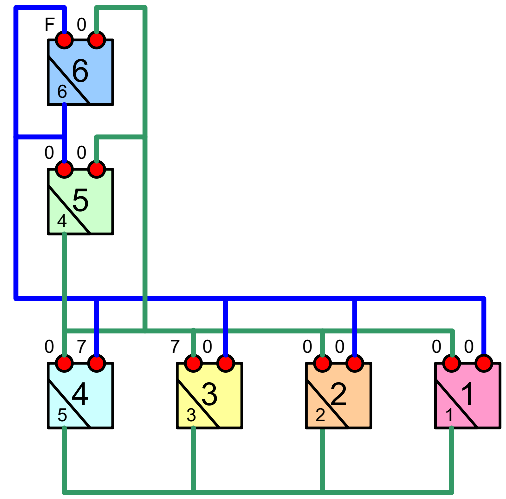
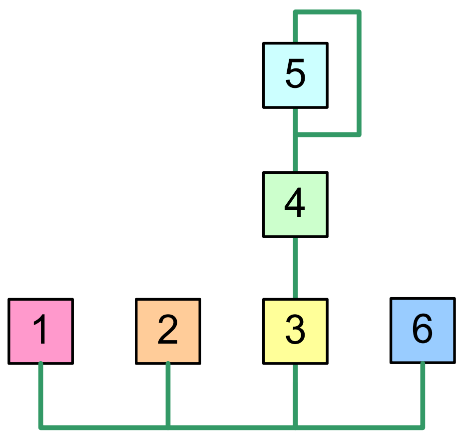
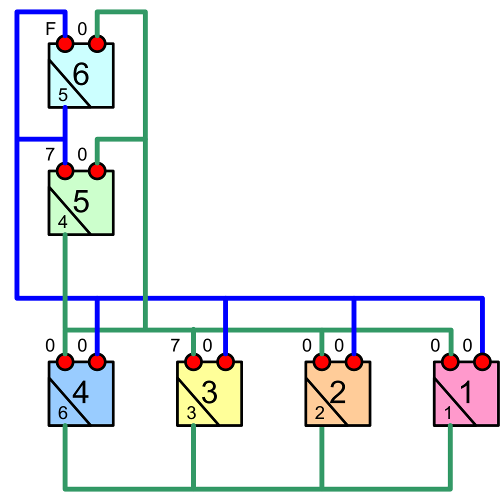
29		43	
30		43	

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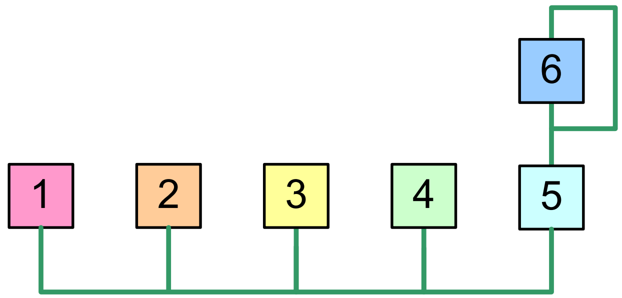
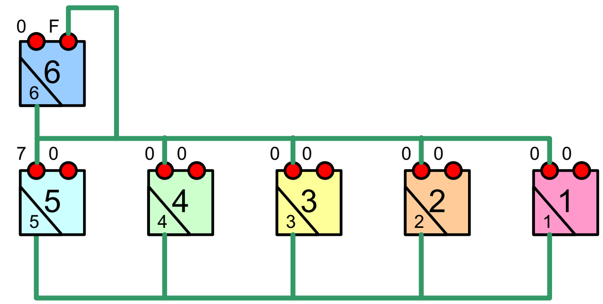
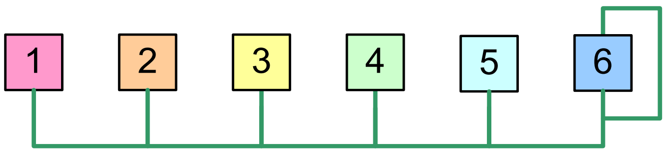
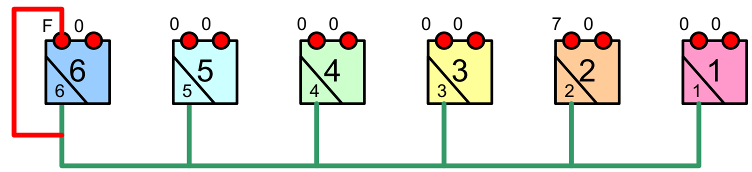
31		44	
32		45	

DX7 to SY77 Algorithm Mapping – Operator Remapping and Values

Note: FBL in the table below is the DX7 feedback level.

Algorithm		Operator Remapping						SY77 Feedback		SY77 Operator Input Levels											
DX7	SY77	OP1	OP2	OP3	OP4	OP5	OP6	SRC	DEST	OP1		OP2		OP3		OP4		OP5		OP6	
										IP1	IP2	IP1	IP2	IP1	IP2	IP1	IP2	IP1	IP2	IP1	IP2
1	30	1	2	3	4	5	6	6	6	7	0	0	0	7	0	7	0	7	0	FBL	0
2	30	1	2	3	4	5	6	2	2	7	0	FBL	0	7	0	7	0	7	0	0	0
3	34	1	2	3	4	5	6	6	6	7	0	7	0	0	0	7	0	7	0	FBL	0
4	34	1	2	3	4	5	6	4	6	7	0	7	0	0	0	7	0	7	0	FBL	0
5	42	1	2	3	4	5	6	6	6	7	0	0	0	7	0	0	0	7	0	FBL	0
6	42	1	2	3	4	5	6	5	6	7	0	0	0	7	0	0	0	7	0	FBL	0
7	32	1	2	3	6	4	5	5	5	7	0	0	0	7	7	7	0	FBL	0	0	0
8	32	1	2	3	6	4	5	6	6	7	0	0	0	7	7	7	0	0	0	FBL	0
9	32	1	2	3	6	4	5	2	2	7	0	FBL	0	7	7	7	0	0	0	0	0
10	35	1	2	3	4	5	6	3	3	7	0	7	0	FBL	0	7	7	0	0	0	0
11	35	1	2	3	4	5	6	6	6	7	0	7	0	0	0	7	7	0	0	FBL	0
12	33	1	2	3	4	5	6	2	2	7	0	FBL	0	7	7	0	0	0	0	0	0
13	33	1	2	3	4	5	6	6	6	7	0	0	0	7	7	0	0	0	0	FBL	0
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15	31	1	2	3	4	5	6	2	2	7	0	FBL	0	7	0	7	7	0	0	0	0
16	16	1	6	4	5	2	3	3	3	7	7	7	0	FBL	0	7	0	0	0	0	0
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19	40	4	5	6	2	1	3	3	3	7	0	7	0	0	FBL	7	0	7	0	0	0
20	41	1	2	3	4	5	6	3	3	7	0	7	0	0	FBL	7	7	0	0	0	0
21	43	1	2	5	4	3	6	5	5	7	0	7	0	0	7	0	7	0	FBL	0	0
22	43	1	5	2	3	4	6	6	6	7	0	0	7	0	7	0	7	0	0	FBL	0
23	43	1	2	5	3	4	6	6	6	0	0	7	0	0	7	0	7	0	0	FBL	0
24	44	1	2	3	4	5	6	6	6	0	0	0	0	7	0	7	0	7	0	0	FBL
25	44	1	2	3	4	5	6	6	6	0	0	0	0	0	0	7	0	7	0	0	FBL
26	41	1	2	3	4	5	6	6	6	0	0	7	0	0	0	7	7	0	0	FBL	0
27	41	1	2	3	4	5	6	3	3	0	0	7	0	0	FBL	7	0	7	0	0	0
28	40	2	3	4	5	6	1	6	6	0	0	7	0	0	0	7	0	7	0	FBL	0
29	43	1	2	3	5	4	6	6	6	0	0	0	0	7	0	0	7	0	0	FBL	0
30	43	1	2	3	5	6	4	6	6	0	0	0	0	7	0	0	0	7	0	FBL	0
31	44	1	2	3	4	5	6	6	6	0	0	0	0	0	0	0	0	7	0	FBL	0
32	45	1	2	3	4	5	6	6	6	0	0	0	0	0	0	0	0	0	0	FBL	0

DX7 to SY77 Algorithm Mapping – Operator Settings for the Different Algorithms

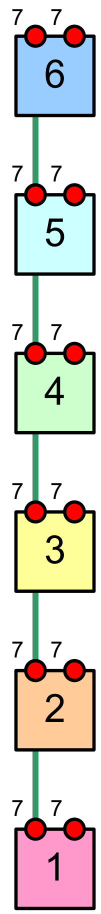
The following section provides the details for each algorithm that I have gleaned from a programmatic perspective, and from examining the user interface connections/settings.

If you are manually converting voices, you do not need to worry about this section as selecting the algorithm in the SY will set all the values for you.

The **Algorithm Settings** table are the values you need for each operator per algorithm to correctly set up the operators.

The Accumulator Calculations are for interest more than anything and will make a little more sense if you read Annex A - SY77 FM Implementation Description on Page 95

Algorithm 1



Algorithm Settings

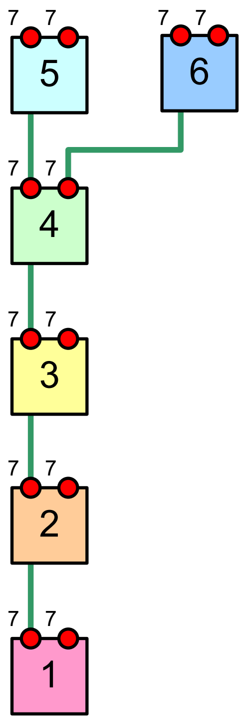
Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	1	1	1	1	0
Oscillator Input Source 1	0	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	0	0	0	1
Out Accumulator Input 1 Source	0	1	1	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value[1]
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	0	1	OP6
2	0	1	OP6
1	1	0	OP1

[1] At the end of each operator calculation

Algorithm 2



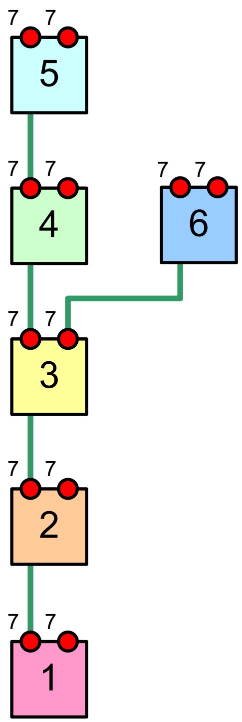
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	1	1	0	0
Oscillator Input Source 1	0	0	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	0	1	0	1
Out Accumulator Input 1 Source	0	1	1	0	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	0	1	OP4
2	0	1	OP4
1	1	0	OP1

Algorithm 3



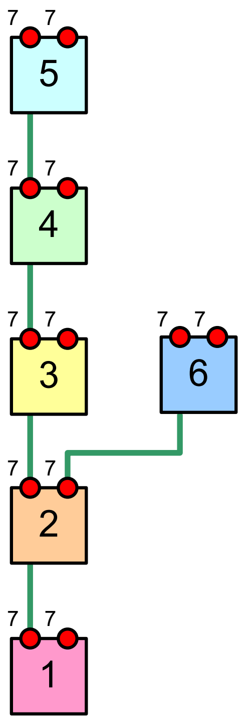
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	1	1	0	0
Oscillator Input Source 1	0	0	9	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	1	0	0	1
Out Accumulator Input 1 Source	0	1	0	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	1	0	OP3
2	0	1	OP3
1	1	0	OP1

Algorithm 4



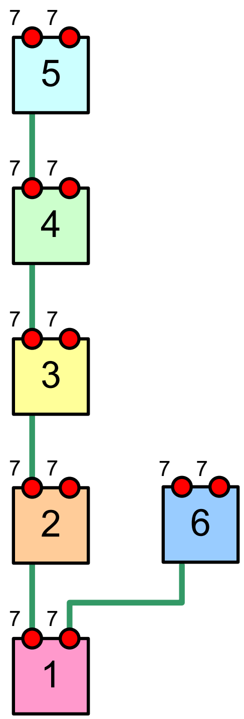
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	1	1	0	0
Oscillator Input Source 1	0	9	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	0	0	0	1
Out Accumulator Input 1 Source	0	1	1	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	0	1	OP6
2	0	1	OP6
1	1	0	OP1

Algorithm 5



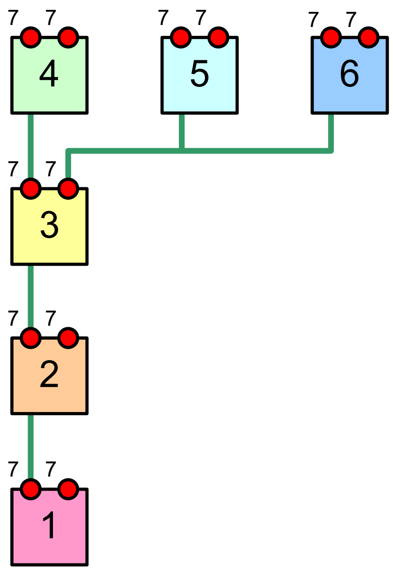
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	1	1	0	0
Oscillator Input Source 1	9	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	0	0	0	1
Out Accumulator Input 1 Source	0	1	1	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	0	1	OP6
2	0	1	OP6
1	1	0	OP1

Algorithm 6



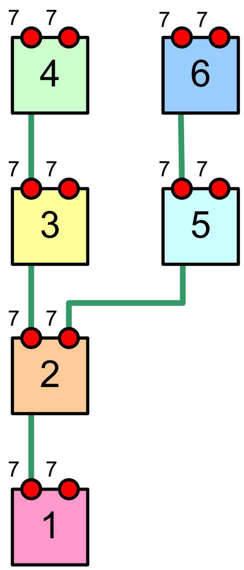
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	1	0	0	0
Oscillator Input Source 1	0	0	9	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	1	0	1	1
Out Accumulator Input 1 Source	0	1	0	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	0	1	OP6 + OP5
3	1	0	OP3
2	0	1	OP3
1	1	0	OP1

Algorithm 7



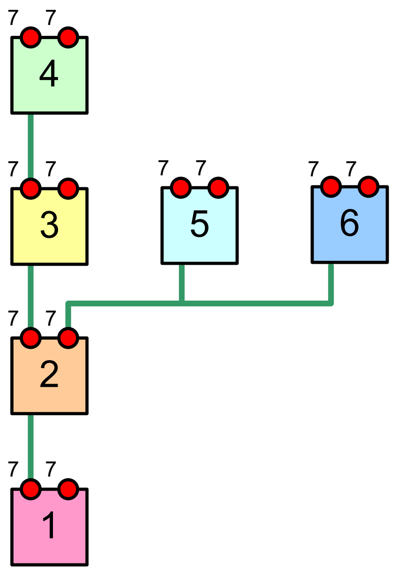
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	1	0	1	0
Oscillator Input Source 1	0	9	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	0	0	1	0
Out Accumulator Input 1 Source	0	1	1	1	0	1
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	0	1	0
5	1	0	OP5
4	0	1	OP5
3	0	1	OP5
2	0	1	OP5
1	1	0	OP1

Algorithm 8



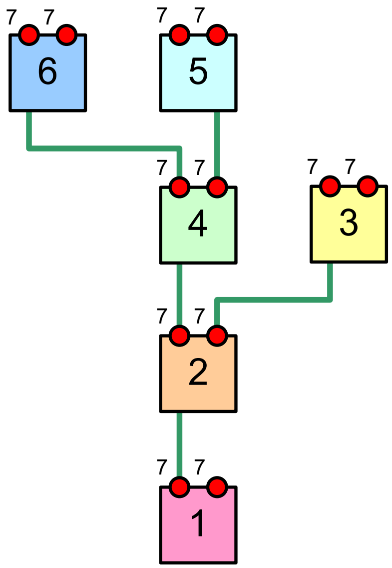
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	1	1	0	0	0
Oscillator Input Source 1	0	9	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	0	0	1	1
Out Accumulator Input 1 Source	0	1	1	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	1	1	OP6 + OP5
4	0	1	OP6 + OP5
3	0	1	OP6 + OP5
2	0	1	OP6 + OP5
1	1	0	OP1

Algorithm 9



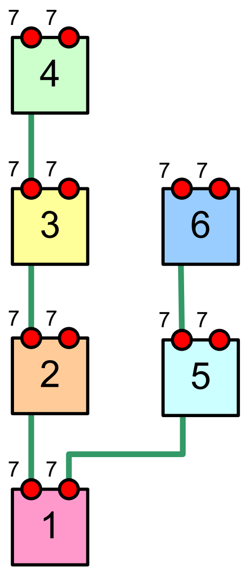
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	1	0	1	0	0
Oscillator Input Source 1	0	9	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	0	0	1	0	1
Out Accumulator Input 1 Source	0	1	1	0	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	0	1	OP4
2	0	1	OP4
1	1	0	OP1

Algorithm 10



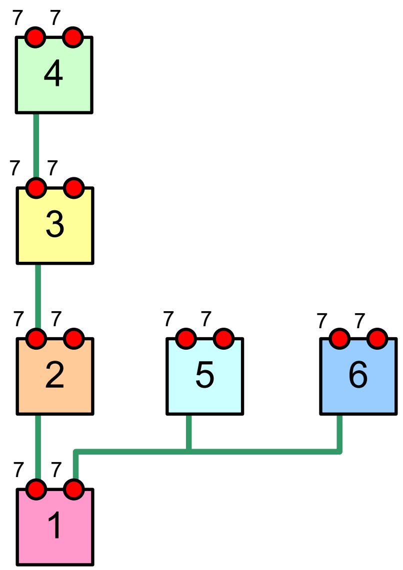
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	1	0	1	0
Oscillator Input Source 1	9	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	0	0	1	0
Out Accumulator Input 1 Source	0	1	1	1	0	1
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	0	1	0
5	1	0	OP5
4	0	1	OP5
3	0	1	OP5
2	0	1	OP5
1	1	0	OP1

Algorithm 11



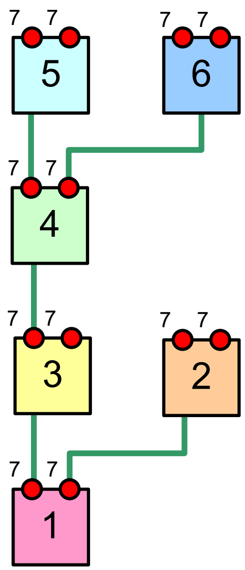
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	1	0	0	0
Oscillator Input Source 1	9	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	0	0	1	1
Out Accumulator Input 1 Source	0	1	1	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	0	1	OP6 + OP5
3	0	1	OP6 + OP5
2	0	1	OP6 + OP5
1	1	0	OP1

Algorithm 12



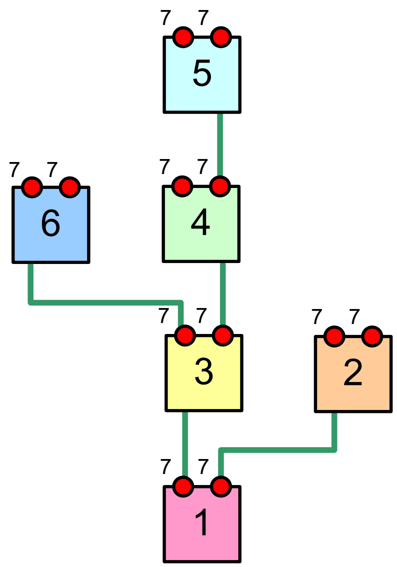
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	0	1	1	0	0
Oscillator Input Source 1	9	0	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	3	0	0	2	1
Out Accumulator Input 0 Source	1	0	1	0	0	1
Out Accumulator Input 1 Source	0	1	0	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	1	0	OP3
2	0	1	OP3
1	1	0	OP1

Algorithm 13



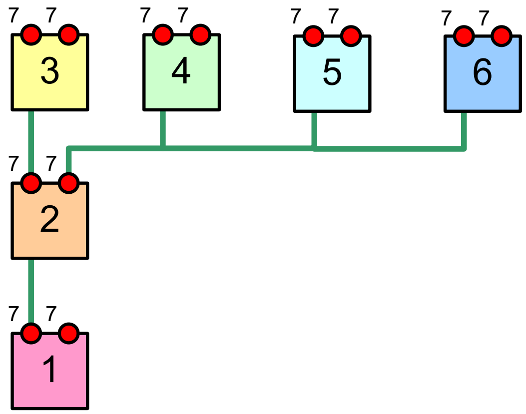
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	0	1	1	0	0
Oscillator Input Source 1	9	0	9	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	3	0	0	2	1
Out Accumulator Input 0 Source	1	0	1	0	0	1
Out Accumulator Input 1 Source	0	1	0	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	1	0	OP3
2	0	1	OP3
1	1	0	OP1

Algorithm 14



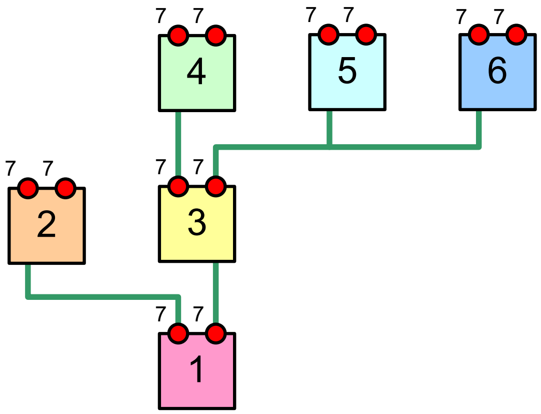
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	0	0	0	0
Oscillator Input Source 1	0	9	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	0	0	1	1	1
Out Accumulator Input 1 Source	0	1	1	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	1	1	OP6 + OP5 + OP4
3	0	1	OP6 + OP5 + OP4
2	0	1	OP6 + OP5 + OP4
1	1	0	OP1

Algorithm 15



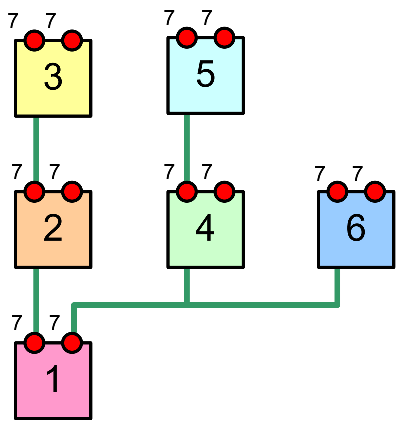
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	0	1	0	0	0
Oscillator Input Source 1	9	0	9	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	3	0	2	0	1
Out Accumulator Input 0 Source	1	0	1	0	1	1
Out Accumulator Input 1 Source	0	1	0	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	0	1	OP6 + OP5
3	1	0	OP3
2	0	1	OP3
1	1	0	OP1

Algorithm 16



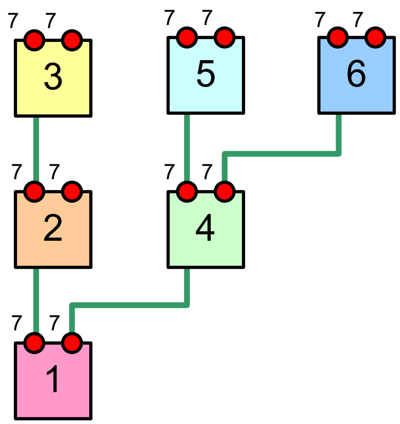
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	1	0	1	0	0
Oscillator Input Source 1	9	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	0	0	1	0	1
Out Accumulator Input 1 Source	0	1	1	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	1	1	OP6 + OP4
3	0	1	OP6 + OP4
2	0	1	OP6 + OP4
1	1	0	OP1

Algorithm 17



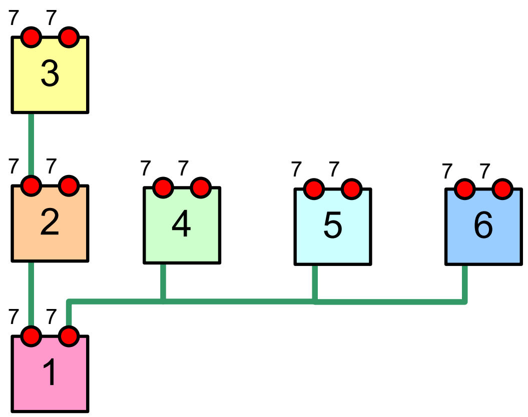
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	1	0	1	0	0
Oscillator Input Source 1	9	0	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	0	0	1	0	1
Out Accumulator Input 1 Source	0	1	1	0	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	0	1	OP4
2	0	1	OP4
1	1	0	OP1

Algorithm 18



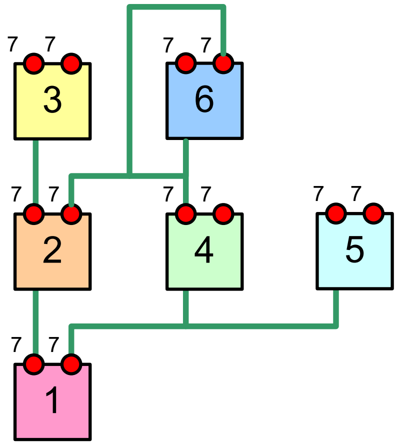
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	0	0	0	0
Oscillator Input Source 1	9	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	0	0	1	1	1
Out Accumulator Input 1 Source	0	1	1	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	1	1	OP6 + OP5 + OP4
3	0	1	OP6 + OP5 + OP4
2	0	1	OP6 + OP5 + OP4
1	1	0	OP1

Algorithm 19



Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	1	0	0	0	0
Oscillator Input Source 1	9	3	0	0	0	6
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	0	0	1	1	0
Out Accumulator Input 1 Source	0	1	1	1	0	1
Output Level Correction	0	0	0	0	0	0

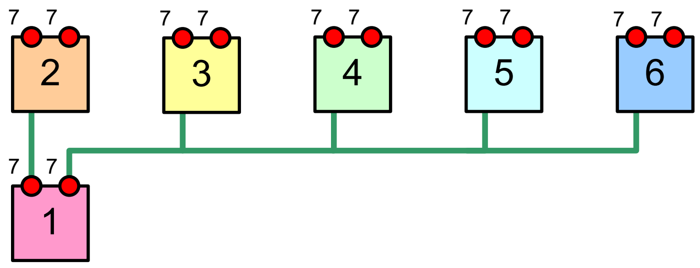
Notes:

- OP6 value is kept in Register 1, whilst the accumulator is used to carry OP5 and OP4 to the input of OP1
- This algorithm has a fixed feedback path on the second input of OP6
- OP6 as the source of FB1 cannot be changed.

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	0	1	0
5	1	0	OP5
4	1	1	OP5 + OP4
3	0	1	OP5 + OP4
2	0	1	OP5 + OP4
1	1	0	OP1

Algorithm 20



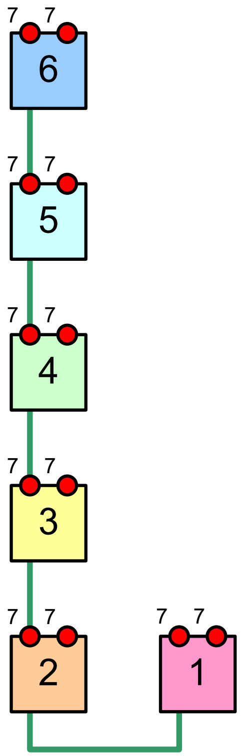
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	0	0	0	0	0
Oscillator Input Source 1	9	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	3	0	0	2	1
Out Accumulator Input 0 Source	1	0	1	1	1	1
Out Accumulator Input 1 Source	0	1	1	1	1	0
Output Level Correction	0	0	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	1	1	OP6 + OP5
4	1	1	OP6 + OP5 + OP4
3	1	1	OP6 + OP5 + OP4 + OP3
2	0	1	OP6 + OP5 + OP4 + OP3
1	1	0	OP1

Algorithm 21



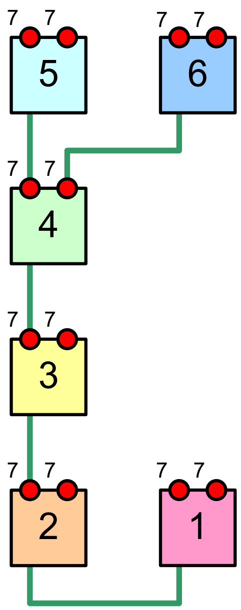
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	0	1	1	1	1	0
Oscillator Input Source 1	0	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	0	0	0	1
Out Accumulator Input 1 Source	1	0	1	1	1	0
Output Level Correction	1	1	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	1	OP6
5	0	1	OP6
4	0	1	OP6
3	0	1	OP6
2	1	0	OP2
1	1	1	OP2 + OP1

Algorithm 22



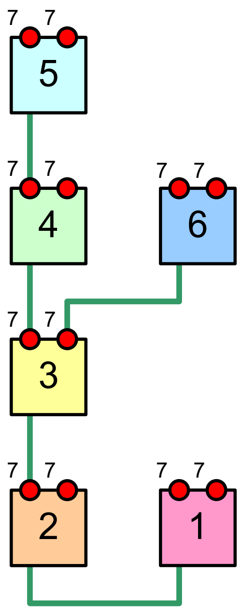
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	0	1	1	1	0	0
Oscillator Input Source 1	0	0	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	1	0	0	0	1
Out Accumulator Input 1 Source	1	0	1	1	1	0
Output Level Correction	1	1	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	0	1	OP6
2	1	0	OP2
1	1	1	OP2 + OP1

Algorithm 23



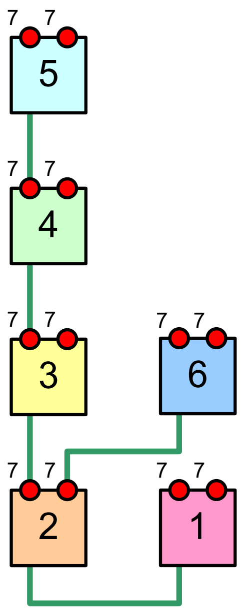
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	0	1	1	1	0	0
Oscillator Input Source 1	0	0	9	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	0	0	0	1
Out Accumulator Input 1 Source	1	0	1	1	1	0
Output Level Correction	1	1	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	0	1	OP6
2	1	0	OP2
1	1	1	OP2 + OP1

Algorithm 24



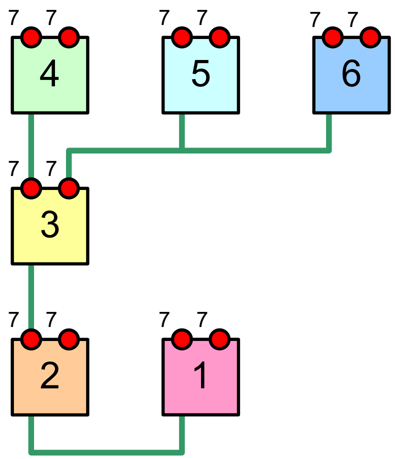
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	0	1	1	1	0	0
Oscillator Input Source 1	0	9	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	0	0	0	1
Out Accumulator Input 1 Source	1	0	1	1	1	0
Output Level Correction	1	1	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	0	1	OP6
2	1	0	OP2
1	1	1	OP2 + OP1

Algorithm 25



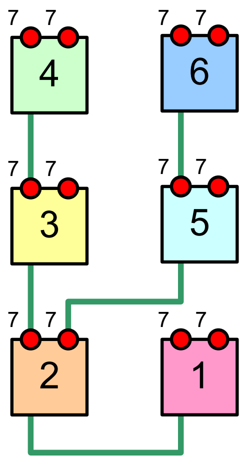
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	0	1	1	0	0	0
Oscillator Input Source 1	0	0	9	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	0	0	1	1
Out Accumulator Input 1 Source	1	0	1	1	1	0
Output Level Correction	1	1	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	0	1	OP6 + OP5
3	0	1	OP6 + OP5
2	1	0	OP2
1	1	1	OP2 + OP1

Algorithm 26



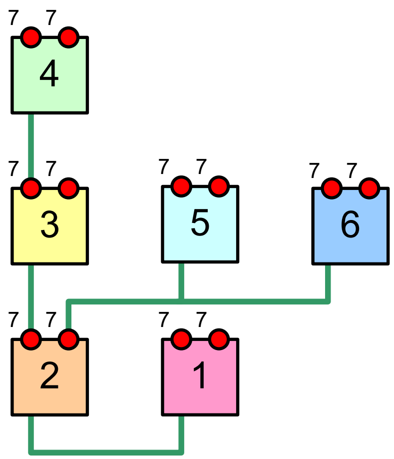
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	0	1	1	0	1	0
Oscillator Input Source 1	0	9	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	0	0	1	0
Out Accumulator Input 1 Source	1	0	1	1	0	1
Output Level Correction	1	1	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	0	1	0
5	1	0	OP5
4	0	1	OP5
3	0	1	OP5
2	1	0	OP2
1	1	1	OP2 + OP1

Algorithm 27



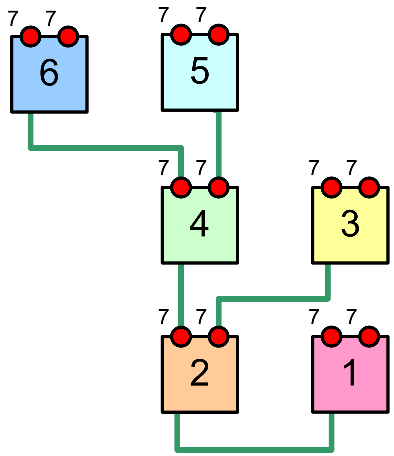
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	0	1	1	0	0	0
Oscillator Input Source 1	0	9	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	0	0	1	1
Out Accumulator Input 1 Source	1	0	1	1	1	0
Output Level Correction	1	1	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	0	1	OP6 + OP5
3	0	1	OP6 + OP5
2	1	0	OP2
1	1	1	OP2 + OP1

Algorithm 28



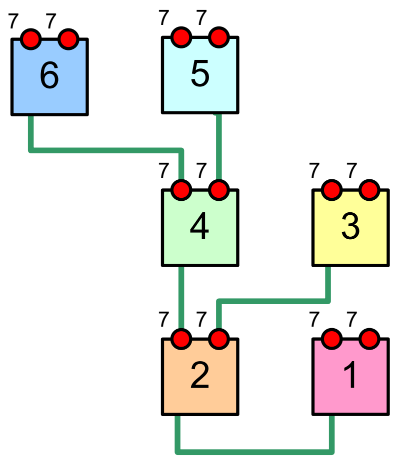
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	0	1	0	1	0	0
Oscillator Input Source 1	0	9	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	1	0	1	0	1
Out Accumulator Input 1 Source	1	0	1	0	1	0
Output Level Correction	1	1	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	0	1	OP4
2	1	0	OP2
1	1	1	OP2 + OP1

Algorithm 29



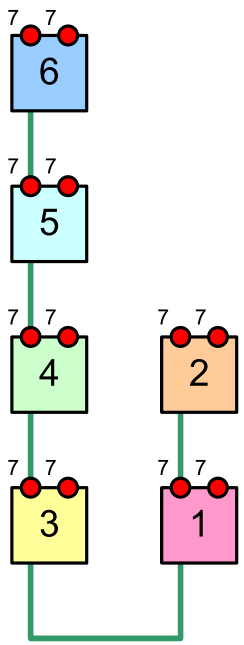
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	0	1	0	0	0	0
Oscillator Input Source 1	0	9	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	1	0	1	1	1
Out Accumulator Input 1 Source	1	0	1	1	1	0
Output Level Correction	1	1	0	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	1	1	OP6 + OP5 + OP4
3	0	1	OP6 + OP5 + OP4
2	1	0	OP2
1	1	1	OP2 + OP1

Algorithm 30



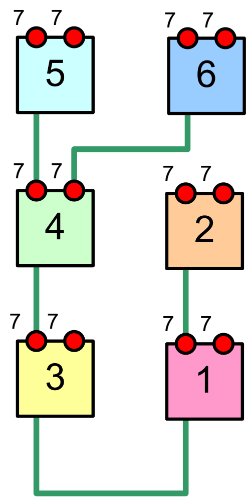
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	0	1	1	1	0
Oscillator Input Source 1	0	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	3	0	0	2	1
Out Accumulator Input 0 Source	1	0	1	0	0	1
Out Accumulator Input 1 Source	1	1	0	1	1	0
Output Level Correction	1	0	1	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	1	0	OP3
2	0	1	OP3
1	1	1	OP3 + OP1

Algorithm 31



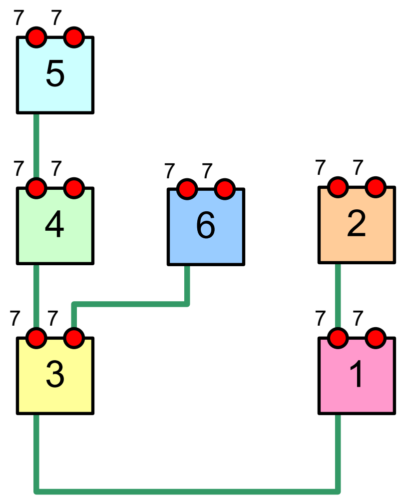
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	0	1	1	0	0
Oscillator Input Source 1	0	0	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	3	0	0	2	1
Out Accumulator Input 0 Source	1	0	1	0	0	1
Out Accumulator Input 1 Source	1	1	0	1	1	0
Output Level Correction	1	0	1	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	1	0	OP3
2	0	1	OP3
1	1	1	OP3 + OP1

Algorithm 32



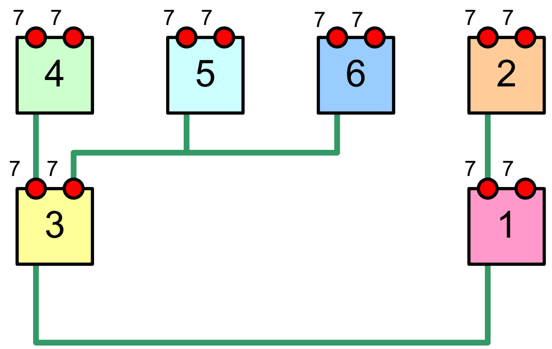
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	1	0	1	1	0	0
Oscillator Input Source 1	0	0	9	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	3	0	0	2	1
Out Accumulator Input 0 Source	1	0	1	0	0	1
Out Accumulator Input 1 Source	1	1	0	1	1	0
Output Level Correction	1	0	1	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	1	0	OP3
2	0	1	OP3
1	1	1	OP3 + OP1

Algorithm 33



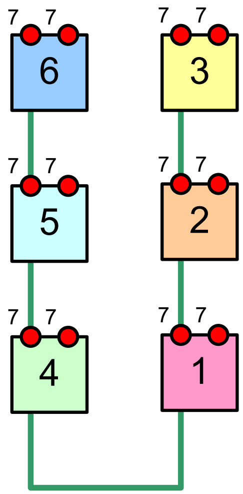
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	0	1	0	0	0
Oscillator Input Source 1	0	0	9	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	3	0	2	0	1
Out Accumulator Input 0 Source	1	0	1	0	1	1
Out Accumulator Input 1 Source	1	1	0	1	1	0
Output Level Correction	1	0	1	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	0	1	OP6 + OP5
3	1	0	OP3
2	0	1	OP3
1	1	1	OP3 + OP1

Algorithm 34



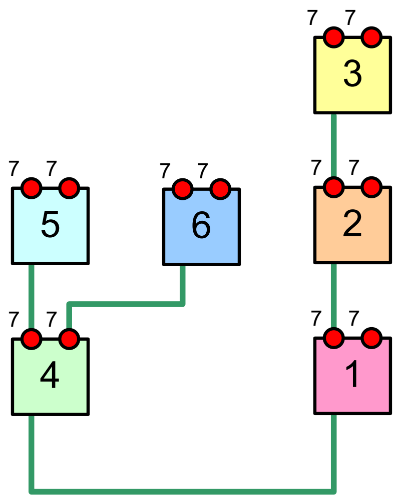
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	0	1	1	0
Oscillator Input Source 1	0	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	0	0	1	0	1
Out Accumulator Input 1 Source	1	1	1	0	1	0
Output Level Correction	1	0	0	1	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	0	1	OP4
2	0	1	OP4
1	1	1	OP4 + OP1

Algorithm 35



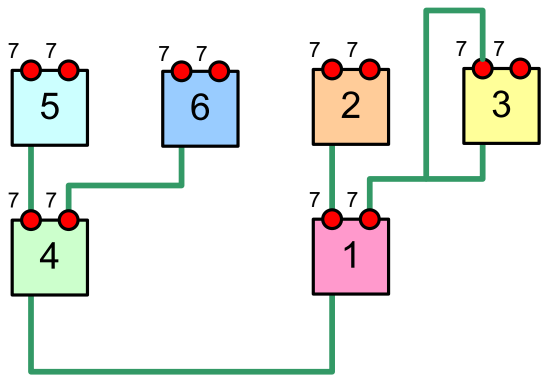
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	1	0	1	0	0
Oscillator Input Source 1	0	0	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	3	0	2	1
Out Accumulator Input 0 Source	1	0	0	1	0	1
Out Accumulator Input 1 Source	1	1	1	0	1	0
Output Level Correction	1	0	0	1	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	0	1	OP4
2	0	1	OP4
1	1	1	OP4 + OP1

Algorithm 36



Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	0	6	1	0	0
Oscillator Input Source 1	3	0	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	1	0	3	2
Out Accumulator Input 0 Source	1	0	0	1	0	1
Out Accumulator Input 1 Source	1	1	1	0	1	0
Output Level Correction	1	0	0	1	0	0

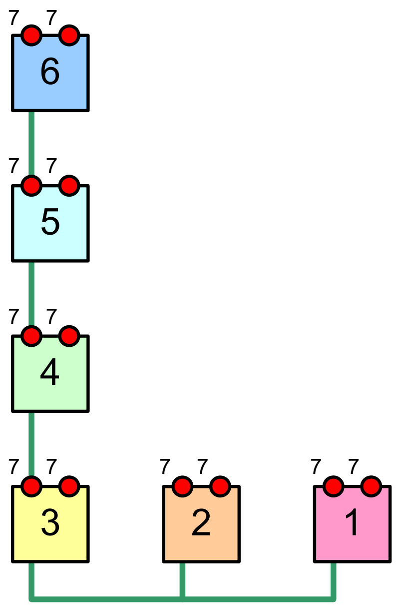
Notes

- Accumulator is used to retain OP6 for OP4 input
- Accumulator is used to retain OP4 for final output
- OP3 inputs to Register 1 for input into OP1
- OP3 also has a fixed feedback path via Register 1 to itself

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	0	1	OP4
2	0	1	OP4
1	1	1	OP4 + OP1

Algorithm 37



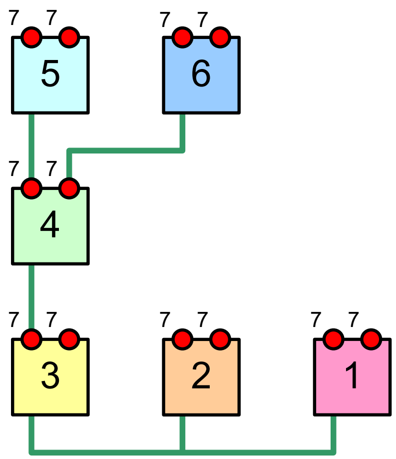
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	0	0	1	1	1	0
Oscillator Input Source 1	0	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	1	0	0	1
Out Accumulator Input 1 Source	1	1	0	1	1	0
Output Level Correction	3	3	3	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	1	0	OP3
2	1	1	OP3 + OP2
1	1	1	OP3 + OP2 + OP1

Algorithm 38



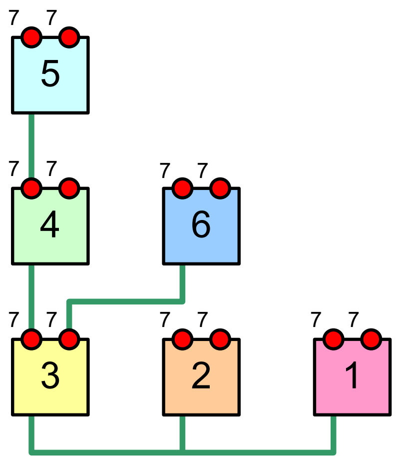
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	0	0	1	1	0	0
Oscillator Input Source 1	0	0	0	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	1	0	0	1
Out Accumulator Input 1 Source	1	1	0	1	1	0
Output Level Correction	3	3	3	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	1	0	OP3
2	1	1	OP3 + OP2
1	1	1	OP3 + OP2 + OP1

Algorithm 39



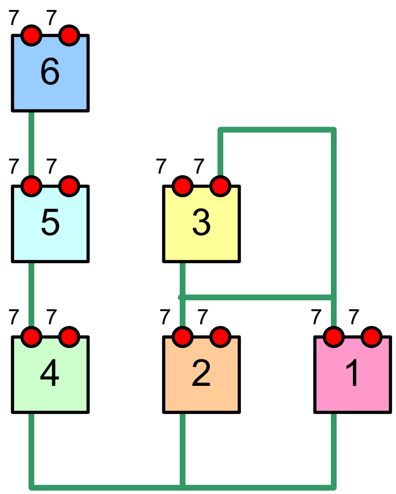
Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	0	0	1	1	0	0
Oscillator Input Source 1	0	0	9	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	1	0	0	1
Out Accumulator Input 1 Source	1	1	0	1	1	0
Output Level Correction	3	3	3	0	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	0	1	OP6
3	1	0	OP3
2	1	1	OP3 + OP2
1	1	1	OP3 + OP2 + OP1

Algorithm 40



Algorithm Settings

Parameter	Operator					
	1	**2**	**3**	**4**	**5**	**6**
Oscillator Input Source 0	3	1	0	1	1	0
Oscillator Input Source 1	0	0	6	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	1	0	3	2
Out Accumulator Input 0 Source	1	1	0	1	0	1
Out Accumulator Input 1 Source	1	1	1	0	1	0
Output Level Correction	3	3	0	3	0	0

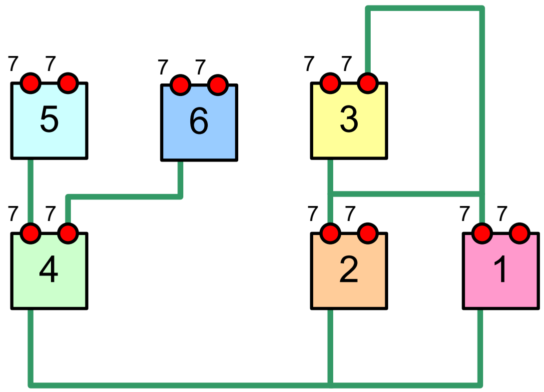
Notes:

- Accumulator retains OP4 value for final summation of carriers.
- OP3 has a fixed destination and feedback via Register 1

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	**Input 1**	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	0	1	OP4
2	1	1	OP4 + OP2
1	1	1	OP4 + OP2 + OP1

Algorithm 41



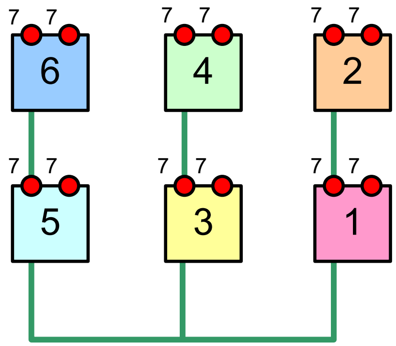
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	3	1	0	1	0	0
Oscillator Input Source 1	0	0	6	9	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	1	0	3	2
Out Accumulator Input 0 Source	1	1	0	1	0	1
Out Accumulator Input 1 Source	1	1	1	0	1	0
Output Level Correction	3	3	0	3	0	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	0	1	OP4
2	1	1	OP4 + OP2
1	1	1	OP4 + OP2 + OP1

Algorithm 42



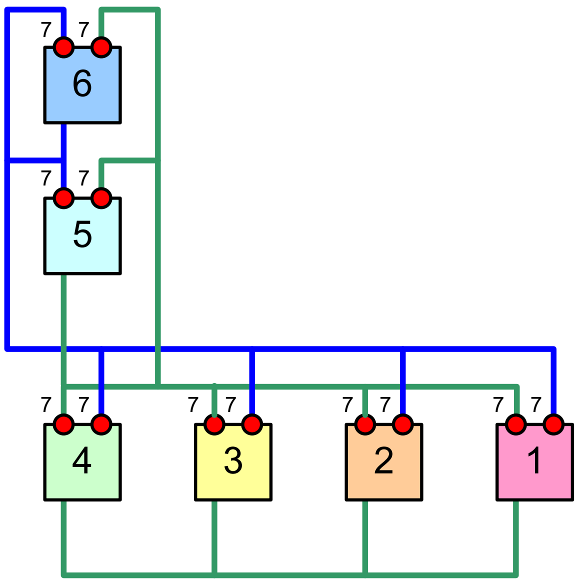
Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	1	0	1	0	1	0
Oscillator Input Source 1	0	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	3	0	2	0	1
Out Accumulator Input 0 Source	1	0	1	0	1	0
Out Accumulator Input 1 Source	1	1	1	1	0	1
Output Level Correction	3	0	3	0	3	0

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	0	1	0
5	1	0	OP5
4	0	1	OP5
3	1	1	OP5 + OP3
2	0	1	OP5 + OP3
1	1	1	OP5 + OP3 + OP1

Algorithm 43



Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	4	4	4	1	1	6
Oscillator Input Source 1	3	3	3	3	7	7
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	0	2	1
Out Accumulator Input 0 Source	1	1	1	1	0	1
Out Accumulator Input 1 Source	1	1	1	0	1	0
Output Level Correction	4	4	4	4	0	0

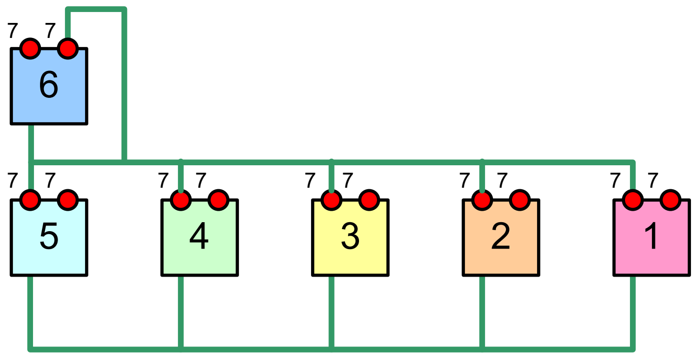
Notes:

- This algorithm has two feedback paths that are fixed for OP5 and OP6 as the accumulator is needed to sum the carrier outputs.
- So Registers 1 and 2 are used for OP6 and OP5 storage

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	0	1	OP6
4	1	0	OP4
3	1	1	OP4 + OP3
2	1	1	OP4 + OP3 + OP2
1	1	1	OP4 + OP3 + OP2 + OP1

Algorithm 44



Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	3	3	3	3	1	0
Oscillator Input Source 1	0	0	0	0	0	6
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	1	1	1	0
Out Accumulator Input 1 Source	1	1	1	1	0	1
Output Level Correction	5	5	5	5	5	0

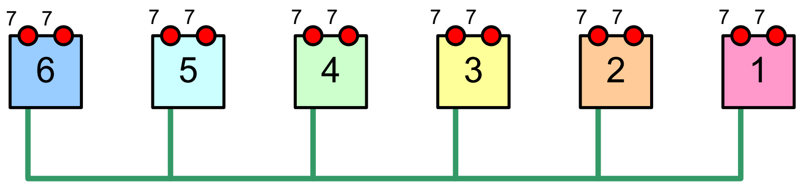
Notes:

- There is a fixed feedback path and register for OP6 feeding the lower operators, as the accumulator is needed for summing the carrier outputs.

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	0	1	OP6
5	1	0	OP6
4	1	1	OP4
3	1	1	OP4 + OP3
2	1	1	OP4 + OP3 + OP2
1	1	1	OP4 + OP3 + OP2 + OP1

Algorithm 45



Algorithm Settings

Parameter	Operator					
	1	2	3	4	5	6
Oscillator Input Source 0	0	0	0	0	0	0
Oscillator Input Source 1	0	0	0	0	0	0
Oscillator Input 0 Shift Value	7	7	7	7	7	7
Oscillator Input 1 Shift Value	7	7	7	7	7	7
Oscillator Output Destination	0	0	0	3	2	1
Out Accumulator Input 0 Source	1	1	1	1	1	1
Out Accumulator Input 1 Source	1	1	1	1	1	0
Output Level Correction	6	6	6	6	6	6

Accumulator Calculations

Operator	Accumulator Inputs		Stored Value
	Input 0	Input 1	
6	1	0	OP6
5	1	1	OP6 + OP5
4	1	1	OP6 + OP5 + OP4
3	1	1	OP6 + OP5 + OP4 + OP3
2	1	1	OP6 + OP5 + OP4 + OP3 + OP2
1	1	1	OP6 + OP5 + OP4 + OP3 + OP2 + OP1

SY77 Algorithm Parameters

This section lists the default algorithm settings for the feedback loop parameters.

Algorithm	Feedback Loop	Source	Operators					
			OP1	OP2	OP3	OP4	OP5	OP6
1	**FB1**	OP6	off	off	off	off	off	off
	FB2	OP5	off	off	off	off	off	off
	FB3	OP4	off	off	off	off	off	off
2	**FB1**	OP6	off	off	off	use	off	off
	FB2	OP5	off	off	off	use	off	off
	FB3	OP4	off	off	off	use	off	off
3	**FB1**	OP6	off	off	use	off	off	off
	FB2	OP5	off	off	use	off	off	off
	FB3	OP4	off	off	use	off	off	off
4	**FB1**	OP6	off	use	off	off	off	off
	FB2	OP5	off	use	off	off	off	off
	FB3	OP4	off	use	off	off	off	off
5	**FB1**	OP6	use	off	off	off	off	off
	FB2	OP5	use	off	off	off	off	off
	FB3	OP4	use	off	off	off	off	off
6	**FB1**	OP6	off	off	use	off	off	off
	FB2	OP5	off	off	use	off	off	off
	FB3	OP4	off	off	use	off	off	off
7	**FB1**	OP6	off	use	off	off	off	off
	FB2	OP5	off	use	off	off	off	off
	FB3	OP4	off	use	off	off	off	off
8	**FB1**	OP6	off	use	off	off	off	off
	FB2	OP5	off	use	off	off	off	off
	FB3	OP4	off	use	off	off	off	off
9	**FB1**	OP6	off	use	off	use	off	off
	FB2	OP5	off	use	off	use	off	off
	FB3	OP3	off	use	off	use	off	off

Algorithm	Feedback Loop	Source	Operators					
			OP1	**OP2**	**OP3**	**OP4**	**OP5**	**OP6**
10	**FB1**	OP6	use	off	off	off	off	off
	FB2	OP5	use	off	off	off	off	off
	FB3	OP4	use	off	off	off	off	off
11	**FB1**	OP6	use	off	off	off	off	off
	FB2	OP5	use	off	off	off	off	off
	FB3	OP4	use	off	off	off	off	off
12	**FB1**	OP6	use	off	off	use	off	off
	FB2	OP5	use	off	off	use	off	off
	FB3	OP2	use	off	off	use	off	off
13	**FB1**	OP6	use	off	use	off	off	off
	FB2	OP5	use	off	use	off	off	off
	FB3	OP2	use	off	use	off	off	off
14	**FB1**	OP6	off	use	off	off	off	off
	FB2	OP5	off	use	off	off	off	off
	FB3	OP3	off	use	off	off	off	off
15	**FB1**	OP6	use	off	use	off	off	off
	FB2	OP4	use	off	use	off	off	off
	FB3	OP2	use	off	use	off	off	off
16	**FB1**	OP6	use	off	off	off	off	off
	FB2	OP5	use	off	off	off	off	off
	FB3	OP3	use	off	off	off	off	off
17	**FB1**	OP6	use	off	off	use	off	off
	FB2	OP5	use	off	off	use	off	off
	FB3	OP3	use	off	off	use	off	off
18	**FB1**	OP6	use	off	off	off	off	off
	FB2	OP5	use	off	off	off	off	off
	FB3	OP4	use	off	off	off	off	off
19	**FB1**	OP6**F**	use	use	off	off	off	**IN2**
	FB2	OP5	use	use	off	off	off	off
	FB3	OP3	use	use	off	off	off	off

Algorithm	Feedback Loop	Source	Operators					
			OP1	**OP2**	**OP3**	**OP4**	**OP5**	**OP6**
20	**FB1**	OP6	use	off	off	off	off	off
	FB2	OP5	use	off	off	off	off	off
	FB3	OP2	use	off	off	off	off	off
21	**FB1**	OP6	off	off	off	off	off	off
	FB2	OP5	off	off	off	off	off	off
	FB3	OP4	off	off	off	off	off	off
22	**FB1**	OP6	off	off	off	use	off	off
	FB2	OP5	off	off	off	use	off	off
	FB3	OP3	off	off	off	use	off	off
23	**FB1**	OP6	off	off	use	off	off	off
	FB2	OP5	off	off	use	off	off	off
	FB3	OP4	off	off	use	off	off	off
24	**FB1**	OP6	off	use	off	off	off	off
	FB2	OP5	off	use	off	off	off	off
	FB3	OP4	off	use	off	off	off	off
25	**FB1**	OP6	off	off	use	off	off	off
	FB2	OP5	off	off	use	off	off	off
	FB3	OP4	off	off	use	off	off	off
26	**FB1**	OP6	off	use	off	off	off	off
	FB2	OP5	off	use	off	off	off	off
	FB3	OP4	off	use	off	off	off	off
27	**FB1**	OP6	off	use	off	off	off	off
	FB2	OP5	off	use	off	off	off	off
	FB3	OP4	off	use	off	off	off	off
28	**FB1**	OP6	off	use	off	use	off	off
	FB2	OP5	off	use	off	use	off	off
	FB3	OP3	off	use	off	use	off	off
29	**FB1**	OP6	off	use	off	off	off	off
	FB2	OP5	off	use	off	off	off	off
	FB3	OP3	off	use	off	off	off	off

Algorithm	Feedback Loop	Source	Operators					
			OP1	**OP2**	**OP3**	**OP4**	**OP5**	**OP6**
30	**FB1**	OP6	off	off	off	off	off	off
	FB2	OP5	off	off	off	off	off	off
	FB3	OP2	off	off	off	off	off	off
31	**FB1**	OP6	off	off	off	use	off	off
	FB2	OP5	off	off	off	use	off	off
	FB3	OP2	off	off	off	use	off	off
32	**FB1**	OP6	off	off	use	off	off	off
	FB2	OP5	off	off	use	off	off	off
	FB3	OP2	off	off	use	off	off	off
33	**FB1**	OP6	off	off	use	off	off	off
	FB2	OP4	off	off	use	off	off	off
	FB3	OP2	off	off	use	off	off	off
34	**FB1**	OP6	off	off	off	off	off	off
	FB2	OP5	off	off	off	off	off	off
	FB3	OP3	off	off	off	off	off	off
35	**FB1**	OP6	off	off	off	use	off	off
	FB2	OP5	off	off	off	use	off	off
	FB3	OP3	off	off	off	use	off	off
36	**FB1**	OP3**F**	use	off	**IN1**	use	off	off
	FB2	OP6	use	off	off	use	off	off
	FB3	OP5	use	off	off	use	off	off
37	**FB1**	OP6	off	off	off	off	off	off
	FB2	OP5	off	off	off	off	off	off
	FB3	OP4	off	off	off	off	off	off
38	**FB1**	OP6	off	off	off	use	off	off
	FB2	OP5	off	off	off	use	off	off
	FB3	OP4	off	off	off	use	off	off
39	**FB1**	OP6	off	off	use	off	off	off
	FB2	OP5	off	off	use	off	off	off
	FB3	OP4	off	off	use	off	off	off

Algorithm	Feedback Loop	Source	Operators					
			OP1	**OP2**	**OP3**	**OP4**	**OP5**	**OP6**
40	**FB1**	OP3**F**	off	off	**IN2**	off	off	off
	FB2	OP6	off	off	off	off	off	off
	FB3	OP5	off	off	off	off	off	off
41	**FB1**	OP3**F**	off	off	**IN2**	use	off	off
	FB2	OP6	off	off	off	use	off	off
	FB3	OP5	off	off	off	use	off	off
42	**FB1**	OP6	off	off	off	off	off	off
	FB2	OP4	off	off	off	off	off	off
	FB3	OP2	off	off	off	off	off	off
43	**FB1**	OP6**F**	use	use	use	use	use	**IN1**
	FB2	OP5**F**	use	use	use	use	**IN2**	**IN2**
	FB3	----	use	use	use	use	use	use
44	**FB1**	OP6**F**	off	off	off	off	off	**IN2**
	FB2	OP5	off	off	off	off	off	off
	FB3	OP4	off	off	off	off	off	off
45	**FB1**	OP6	off	off	off	off	off	off
	FB2	OP5	off	off	off	off	off	off
	FB3	OP4	off	off	off	off	off	off

The following table identifies the operator inputs that are predefined depending on the algorithm.

Algorithm	Input	Operators					
		OP1	OP2	OP3	OP4	OP5	OP6
1	Input 1	OP2	OP3	OP4	OP5	OP6	off
	Input 2	Off	off	off	off	off	off
2	Input 1	OP2	OP3	OP4	OP5	off	off
	Input 2	Off	off	off	OPA[2]	off	off
3	Input 1	OP2	OP3	OP4	OP5	off	off
	Input 2	off	OPA	OPA	off	off	off
4	Input 1	OP2	OP3	OP4	OP5	off	off
	Input 2	off	OPA	off	off	off	off
5	Input 1	OP2	OP3	OP4	OP5	off	off
	Input 2	OPA	off	off	off	off	off
6	Input 1	OP2	OP3	OP4	off	off	off
	Input 2	off	off	OPA	off	off	off
7	Input 1	OP2	OP3	OP4	off	OP6	off
	Input 2	off	OPA	off	off	off	off
8	Input 1	OP2	OP3	OP4	off	off	off
	Input 2	off	OPA	off	off	off	off
9	Input 1	OP2	OP3	off	OP5	off	off
	Input 2	off	OPA	off	OPA	off	off
10	Input 1	OP2	OP3	OP4	off	OP6	off
	Input 2	OPA	off	off	off	off	off
11	Input 1	OP2	OP3	OP4	off	off	off
	Input 2	OPA	off	off	off	off	off
12	Input 1	OP2	off	OP4	OP5	off	off
	Input 2	OPA	off	off	OPA	off	off
13	Input 1	OP2	off	OP4	OP5	off	off
	Input 2	OPA	off	OPA	off	off	off
14	Input 1	OP2	OP3	off	off	off	off

[2] This is the accumulator

Algorithm	Input	Operators					
		OP1	**OP2**	**OP3**	**OP4**	**OP5**	**OP6**
	Input 2	off	OPA	off	off	off	off
15	**Input 1**	OP2	off	OP4	off	off	off
	Input 2	OPA	off	OPA	off	off	off
16	**Input 1**	OP2	OP3	off	OP5	off	off
	Input 2	OPA	off	off	off	off	off
17	**Input 1**	OP2	OP3	off	OP5	off	off
	Input 2	OPA	off	off	OPA	off	off
18	**Input 1**	OP2	OP3	off	off	off	off
	Input 2	OPA	off	off	off	off	off
19	**Input 1**	OP2	OP3	off	off	off	off
	Input 2	OPA	OP6	off	off	off	**FBOP6**
20	**Input 1**	OP2	off	off	off	off	off
	Input 2	OPA	off	off	off	off	off
21	**Input 1**	off	OP3	OP4	OP5	OP6	off
	Input 2	off	off	off	off	off	off
22	**Input 1**	off	OP3	OP4	OP5	off	off
	Input 2	off	off	off	OPA	off	off
23	**Input 1**	off	OP3	OP4	OP5	off	off
	Input 2	off	off	OPA	off	off	off
24	**Input 1**	off	OP3	OP4	OP5	off	off
	Input 2	off	OPA	off	off	off	off
25	**Input 1**	off	OP3	OP4	off	off	off
	Input 2	off	off	OPA	off	off	off
26	**Input 1**	off	OP3	OP4	off	off	off
	Input 2	off	OPA	off	off	off	off
27	**Input 1**	off	OP3	OP4	off	off	off
	Input 2	off	OPA	off	off	off	off
28	**Input 1**	off	OP3	off	OP5	off	off
	Input 2	off	OPA	off	OPA	off	off
29	**Input 1**	off	OP3	off	off	off	off

Algorithm	Input	Operators					
		OP1	**OP2**	**OP3**	**OP4**	**OP5**	**OP6**
	Input 2	off	OPA	off	off	off	off
30	**Input 1**	off	off	OP4	OP5	OP6	off
	Input 2	off	off	off	off	off	off
31	**Input 1**	OP2	off	OP4	OP5	off	off
	Input 2	off	off	off	OPA	off	off
32	**Input 1**	OP2	off	OP4	OP5	off	off
	Input 2	off	off	OPA	off	off	off
33	**Input 1**	OP2	off	OP4	off	off	off
	Input 2	off	off	OPA	off	off	off
34	**Input 1**	OP2	OP3	off	OP5	OP6	off
	Input 2	off	off	off	off	off	off
35	**Input 1**	OP2	OP3	off	OP5	off	off
	Input 2	off	off	off	OPA	off	off
36	**Input 1**	OP2	off	**FBOP3**	OP5	off	off
	Input 2	OP3	off	off	OPA	off	off
37	**Input 1**	off	off	OP4	OP5	OP6	off
	Input 2	off	off	off	off	off	off
38	**Input 1**	off	off	OP4	OP5	off	off
	Input 2	off	off	off	OPA	off	off
39	**Input 1**	off	off	OP4	OP5	off	off
	Input 2	off	off	OPA	off	off	off
40	**Input 1**	OP3	off	off	off	off	off
	Input 2	off	off	**FBOP3**	off	off	off
41	**Input 1**	OP3	off	off	off	off	off
	Input 2	off	off	**FBOP3**	off	off	off
42	**Input 1**	OP2	off	OP4	off	OP6	off
	Input 2	off	off	off	off	off	off
43	**Input 1**	OP5	OP5	OP5	OP5	OP5	**FBOP6**
	Input 2	OP6	OP6	OP6	OP6	OP6	**FBOP5**
44	**Input 1**	OP6	OP6	OP6	OP6	OP6	off

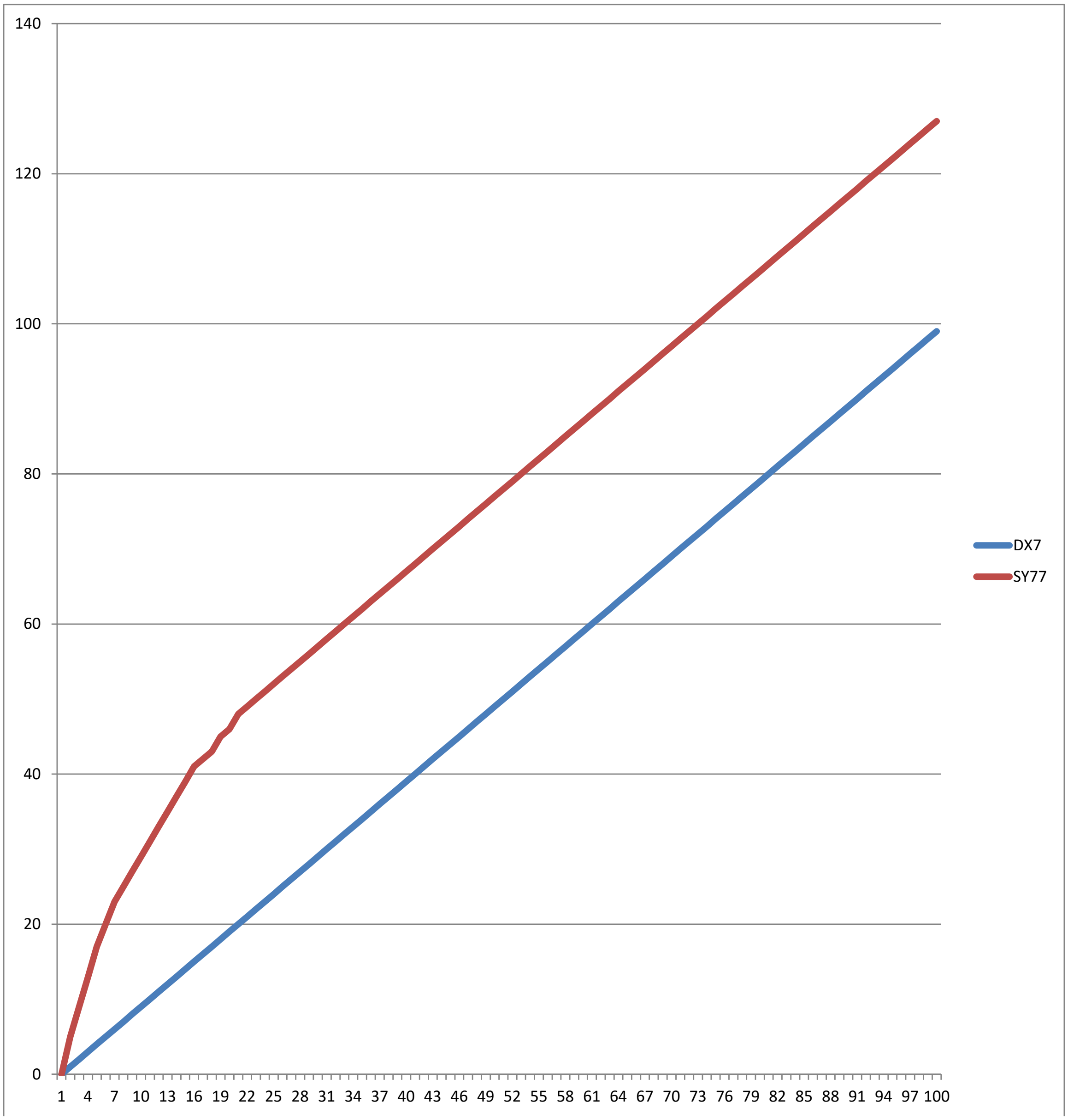
Algorithm	Input	Operators					
		OP1	OP2	OP3	OP4	OP5	OP6
	Input 2	off	off	off	off	off	**FBOP6**
45	**Input 1**	off	off	off	off	off	off
	Input 2	off	off	off	off	off	off

DX7 to SY Level Scaling

Either use a linear multiplier of 1.571428571428571 (99/63), or use the scaling table below for better results.

DX7	SY	Scaling	DX7	SY	Scaling	DX7	SY	Scaling	DX7	SY	Scaling
0	0	0.0000000	25	53	2.1200000	50	78	1.5600000	75	103	1.3733333
1	5	5.0000000	26	54	2.0769231	51	79	1.5490196	76	104	1.3684211
2	9	4.5000000	27	55	2.0370370	52	80	1.5384615	77	105	1.3636364
3	13	4.3333333	28	56	2.0000000	53	81	1.5283019	78	106	1.3589744
4	17	4.2500000	29	57	1.9655172	54	82	1.5185185	79	107	1.3544304
5	20	4.0000000	30	58	1.9333333	55	83	1.5090909	80	108	1.3500000
6	23	3.8333333	31	59	1.9032258	56	84	1.5000000	81	109	1.3456790
7	25	3.5714286	32	60	1.8750000	57	85	1.4912281	82	110	1.3414634
8	27	3.3750000	33	61	1.8484848	58	86	1.4827586	83	111	1.3373494
9	29	3.2222222	34	62	1.8235294	59	87	1.4745763	84	112	1.3333333
10	31	3.1000000	35	63	1.8000000	60	88	1.4666667	85	113	1.3294118
11	33	3.0000000	36	64	1.7777778	61	89	1.4590164	86	114	1.3255814
12	35	2.9166667	37	65	1.7567568	62	90	1.4516129	87	115	1.3218391
13	37	2.8461538	38	66	1.7368421	63	91	1.4444444	88	116	1.3181818
14	39	2.7857143	39	67	1.7179487	64	92	1.4375000	89	117	1.3146067
15	41	2.7333333	40	68	1.7000000	65	93	1.4307692	90	118	1.3111111
16	42	2.6250000	41	69	1.6829268	66	94	1.4242424	91	119	1.3076923
17	43	2.5294118	42	70	1.6666667	67	95	1.4179104	92	120	1.3043478
18	45	2.5000000	43	71	1.6511628	68	96	1.4117647	93	121	1.3010753
19	46	2.4210526	44	72	1.6363636	69	97	1.4057971	94	122	1.2978723
20	48	2.4000000	45	73	1.6222222	70	98	1.4000000	95	123	1.2947368
21	49	2.3333333	46	74	1.6086957	71	99	1.3943662	96	124	1.2916667
22	50	2.2727273	47	75	1.5957447	72	100	1.3888889	97	125	1.2886598
23	51	2.2173913	48	76	1.5833333	73	101	1.3835616	98	126	1.2857143
24	52	2.1666667	49	77	1.5714286	74	102	1.3783784	99	127	1.2828283

This is shown graphically below



140
120
100
80
60
40
20
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85 88 91 94 97 100
DX7
SY77

DX7 to SY Scaling Constants

Parameter	Calulcation	Scaling Value
• DX7 ENVELOPE VALUE SCALING • DX7 PITCH EG RATE SCALING • DX7 OPERATOR EG RATE SCALING • DX7 OPERATOR EG LEVEL SCALING • DX7II PAN EG RATE SCALING	(99.0/63.0)	1.571428571428571
• DX7 OUTPUT LEVEL VALUE SCALING • DX7 OUTPUT LEVEL OFFSET SCALING • DX7 LFO DEPTH SCALING • DX7 LFO PMD SCALING • DX7 LFO AMD SCALING	(127.0/99.0)	1.282828282828283
• DX7 PITCH EG LEVEL SCALING	(63.0/49.0)	1.285714285714286
• DX7 AMPLITUDE MODULATION SENSITIVITY SCALING	(7.0/3.0)	2.333333333333333
• DX7II BALANCE SCALING	(127.0/50.0)	2.54
• DX7II PAN EG LEVEL SCALING	(32.0/50.0)	0.64

DX7 to SY Lookup Tables

The following tables are Java arrays that are used within sy.factory to convert DX to SY values. The DX value is used as the index into the array to "look up" the equivalent SY value.

The reasons for using lookup tables are manifold:

- Speed and efficiency:
  - The DX and SY parameters are integer values, but the computations for scaling will need to be computed using floating point arithmetic and then rounded to integers, so simple lookups save repeated computation and rounding.
  - Speed and efficiency are of course less of issue these days with the processing power of modern computers, but if you are doing bulk conversions of loads of files then every little speed gain helps the overall conversion time.
- Some relationships between DX and SY values are not linear, so difficult if not impossible to compute with an equation – e.g. algorithm mapping, the non linear operator rate scaling, etc.

If time permits, and if there is the interest, I may convert these Java lookup tables into Word tables to assist manual computation. In the meantime if you wish to create your own tables (and if you do please send them to me for inclusion here!) then create a Word table simular to the one given above for the level scaling, with a column for the DX value and a column for the SY value. The DX Column value starts at zero and increased by one for each row and you need as many rows as there are lookup entries. The SY Column values are taken from the data below.

```
private static int algorithmMapping[] = {

       // Displayed algorithms numbers are the values listed below + 1
       //00,01,02,03,04,05,06,07,08,09,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,
         29,29,33,33,41,41,31,31,31,34,34,32,32,30,30,15,15,10,39,40,42,42,42,43,43,40,40,39,42,42,43,44

};

private static int operatorOutputLevelScaling[] = {

         0,   5,   9,  13,  17,  20,  23,  25,  27,  29,
        31,  33,  35,  37,  39,  41,  42,  43,  45,  46,
        48,  49,  50,  51,  52,  53,  54,  55,  56,  57,
        58,  59,  60,  61,  62,  63,  64,  65,  66,  67,
        68,  69,  70,  71,  72,  73,  74,  75,  76,  77,
        78,  79,  80,  81,  82,  83,  84,  85,  86,  87,
        88,  89,  90,  91,  92,  93,  94,  95,  96,  97,
        98,  99, 100, 101, 102, 103, 104, 105, 106, 107,
       108, 109, 110, 111, 112, 113, 114, 115, 116, 117,
       118, 119, 120, 121, 122, 123, 124, 125, 126, 127,
};
```

```java
private static int pitchEgRateScaling[] = {

          0,  1,  1,  2,  3,  3,  4,  4,  5,  5,
          6,  6,  7,  7,  8,  8,  9,  9, 10, 10,
         11, 12, 12, 13, 14, 15, 15, 16, 17, 18,
         18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
         28, 29, 30, 31, 32, 33, 34, 35, 36, 37,
         38, 39, 40, 40, 41, 42, 42, 43, 43, 43,
         44, 45, 45, 46, 47, 47, 48, 48, 49, 49,
         50, 50, 51, 52, 52, 53, 53, 54, 54, 55,
         55, 56, 56, 56, 57, 57, 58, 58, 59, 59,
         60, 60, 61, 61, 61, 62, 62, 62, 63, 63,

};

private static int pitchEgLevelScaling[] = {

        39, 39, 40, 40, 41, 41, 42, 42, 43, 43,
        44, 44, 45, 45, 46, 46, 47, 47, 48, 48,
        49, 49, 50, 50, 51, 51, 52, 52, 53, 53,
        54, 54, 55, 55, 56, 56, 57, 57, 58, 58,
        59, 59, 60, 60, 61, 61, 62, 62, 63, 63,
        64, 64, 65, 65, 66, 66, 67, 67, 68, 68,
        69, 69, 70, 70, 71, 71, 72, 72, 73, 73,
        74, 74, 75, 75, 76, 76, 77, 77, 78, 78,
        79, 79, 80, 80, 81, 81, 82, 82, 83, 83,
        84, 84, 85, 85, 86, 86, 87, 87, 88, 88,

};

private static int operatorEgRateScaling[] = {

         0,  1,  1,  2,  3,  3,  4,  4,  5,  5,
         6,  6,  7,  7,  8,  8,  9,  9, 10, 10,
        11, 12, 12, 13, 14, 15, 15, 16, 17, 18,
        18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
        28, 29, 30, 31, 32, 33, 34, 35, 36, 37,
        38, 39, 40, 40, 41, 42, 42, 43, 43, 43,
        44, 45, 45, 46, 47, 47, 48, 48, 49, 49,
        50, 50, 51, 52, 52, 53, 53, 54, 54, 55,
        55, 56, 56, 56, 57, 57, 58, 58, 59, 59,
        60, 60, 61, 61, 61, 62, 62, 62, 63, 63,

};
```

```java
private static int operatorEgLevelScaling[] = {

         0,  1,  1,  2,  3,  3,  4,  4,  5,  5,
         6,  6,  7,  7,  8,  8,  9,  9, 10, 10,
        11, 12, 12, 13, 14, 15, 15, 16, 17, 18,
        18, 19, 20, 21, 22, 23, 24, 25, 26, 27,
        28, 29, 30, 31, 32, 33, 34, 35, 36, 37,
        38, 39, 40, 40, 41, 42, 42, 43, 43, 43,
        44, 45, 45, 46, 47, 47, 48, 48, 49, 49,
        50, 50, 51, 52, 52, 53, 53, 54, 54, 55,
        55, 56, 56, 56, 57, 57, 58, 58, 59, 59,
        60, 60, 61, 61, 61, 62, 62, 62, 63, 63,

        };

private static int lfoSpeedScaling[] = {

         0,  2,  4,  6,  8, 10, 12, 14, 17, 20,
        23, 25, 27, 29, 31, 34, 36, 38, 39, 40,
        42, 43, 45, 46, 47, 48, 49, 50, 52, 53,
        54, 55, 56, 57, 58, 59, 60, 61, 62, 62,
        63, 64, 65, 66, 67, 68, 68, 69, 69, 70,
        71, 71, 72, 72, 73, 73, 74, 75, 76, 76,
        77, 77, 78, 78, 79, 79, 80, 80, 81, 81,
        82, 82, 83, 83, 84, 84, 85, 85, 86, 86,
        87, 87, 88, 89, 89, 90, 91, 91, 92, 92,
        93, 94, 94, 95, 95, 96, 96, 97, 98, 99,

};

private static int amplitudeModulationSensitivityScaling[] = {

        0, 2, 5, 7

};

private static int panMode[] = {

        2, 0, 1

};
```

Annex A - SY77 FM Implementation Description

This Annex describes the SY77 FM Implementation as I understand it. The intent of collating this information is to assist in the implementation of features in sy.factory that require such an understanding. The information has been gleaned from reverse engineering the SY77 SYSEX file data, to fill in the information which has not been included in the SY77 manual or data lists.

Disclaimer

This information is based on my understanding of the SY77 implementation, and may or may not have errors in it. I have provided this information freely, and you use the contents AS IS and at your own risk. If you find any material errors, then please let me know and I'll make any required corrections.

Overview

The SY77 has quite an advanced 6 operator architecture compared to the DX7, where all of the algorithms were fixed with no flexibility in terms of how the algorithms could be adapted, other than being able to program operator output levels and the input of the single feedback level on the fixed feedback path. By contrast, the SY77 features more algorithms, three programmable feedback paths, alternative modulating inputs from the AWM section and a noise generator, and a (not very well publicised) programmable "free algorithm".

For each output sample, the six operators are calculated in reverse order first. I.e. Operator 6, then Operator 5 and so on, which fixes the operator algorithm permutations.

To allow the results of prior operator calculations to be used in the sample calculation for subsequent operators there are three registers that can temporarily hold an operator output value and an accumulator which can sum the calculated sample value for the operators. There are also three programmable feedback paths.

Thru Paths

Before looking at Registers and Accumulators, it is worth considering **Thru Paths**, as most connections in an algorithm are made this way. Basically a through connection can be made from an Operator whose number is one greater than the Operator it is connecting to.

for example, Algorithm 1 has a full sequential stack of operators, from 6, 5, 4, 3, 2 to 1. All of the connections are made via simple **Thru Paths**.

I hypothesise that there is an extra register that stores the value of the last operator calculation, which is then replaced by each subsequent operator calculation.

Registers and Feedback Paths

The FM implementation has three registers which can be used to store the value of an operator calculation. These registers can be used in later calculations, so because of the calculation flow, a stored value in a register can only be used in a calculation for an Operator that is lower in number than the Operator whose value is stored in a register.

For example, if Operator 3 is an input to a register, then it can be used as an input to Operators 1 and 2, but not Operators 4, 5, and 6.

I don't think that there is a way to program these registers other than them being hard coded into certain algorithms. For example, the ones where feedback paths are fixed and cannot be changed:

- Algorithm 19
- Algorithm 36
- Algorithm 40
- Algorithm 41
- Algorithm 43
- Algorithm 44

I believe that these registers are required to hold calculations of operator values whilst the accumulator is also in use for other calculations in the algorithm, hence why these algorithms have fixed paths that cannot be changed. For example, on Algorithm 19, the outputs of 4 and 5 are probably being summed in the accumulator, so the value of Operator 6 must be held in a register as an input for Operator 2 when its sample is calculated.

I also think the same registers are used for providing the feedback paths as on the algorithms listed above, the feedback paths are fixed and cannot be changed.

Taking Algorithm 19 again as an example, you can see there is a need to provide the operator 6 value to operator 2, and there is a fixed feedback path to Operator 6 as part of the algorithm.

This hypothesis is derived from the examination of the algorithms for which there are fixed feedback paths.

If you consider a set of Operator sample calculations as a continuous stream of calculations in the series … N-2, N-1, N, N+1, N+2 … where N is the current sample calculation:

- A register can be used in the current cycle to provide the current value of an operator for use later in the calculation.
- A register can be used to retain the value of an operator for the next sample calculation cycle (feedback), so for sample N, the value of a register will hold a calculated sample of the selected operator as calculated in sample cycle N-1.

When used in a current calculation, a register cannot feed a higher operator number from a lower operator number (because of the operator calculation order). When used to provide feedback, then any Operator's N-1 sample value can be used as an input to any Operator (as it is available at the start of the calculation cycle).

It looks like the Accumulator (see below) is used in preference to using a register for storing single operator values until needed, because (I believe) use of a register ties up a feedback path.

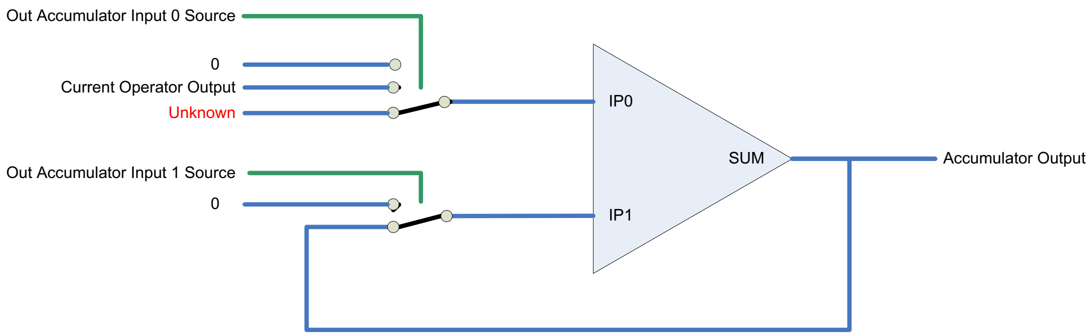
If an algorithm can use the accumulator without requiring a register, then no feedback paths are tied up. I.e., you only see fixed feedback paths where the accumulator is needed for summing later results. For example, on Algorithm 36, there is a fixed feedback path (and register to OP1) on OP3, because the accumulator is needed to sum OP4 and OP1, and it is used to store OP6 prior to that.

Accumulator

It took me a long while to suss out what the input values into the accumulator where, and how they might work.

The following diagram shows how I think that the accumulator works. Note that in the algorithm details given previously in the document, I have looked at the accumulator input selects in each operator and mapped through how they work to verify that my understanding is correct. It seems to hang together for all algorithms!

I am assuming that the accumulator is reset at the start of each complete operator calculation cycle. It makes no sense for it to retain previous values anyway.



Basically, I believe that IP1 can be selected to be either 0 or the current output of the accumulator.

IP0 can be selected to be either 0, or the output of the most recently calculated operator sample value. The SY77 data list identifies that the value can vary between 0 and 2 without explaining what the values represent! In the examinations so far, I have seen nothing to indicate what the 3rd input on IP0 can be. So, it's still a bit of a mystery.

The following table shows the accumulator input selection logic as I understand it (not withstanding what the 3rd IP0 input might be).

IP0 Value	IP1 Value	Accumulator Result
0	0	The output of the accumulator is reset to zero, although it should be noted, that in the algorithms, this value never occurs. The accumulator is either set to the OP6 calculated value or, the current accumulator value (which I presume is zero at the start of the cycle, therefore maybe the start of the cycle commences with this set if inputs to perform a reset).
1	0	The output of the accumulator will be the value of the current operator's sample value.
0	1	The Output of the accumulator will be its previous value. This is a way of preserving the accumulator value until it is needed as an input into an operator or until it needs to be summed.
1	1	The current accumulator output is summed with the current operator's sample value.

IP0 is always 1 for operator 1, as it's always a carrier output.

The accumulator is effectively the output of all the carriers in an algorithm, so this is the value output to the rest of the AFM engine.

Sources of Inputs to Operators

Based on the above notes, and by reverse engineering the byte values in an SY77 SYSEX dump for different program settings, the available operator input sources and their numeric representation are:

- 0 Off (no input)
- 1 Previous Operator (Thru Path)
- 2 AWM Element (RCM)
- 3 Register 1 (current cycle only, from high operator to low operator)
- 4 Register 2 (current cycle only, from high operator to low operator)
- 5 Register 3 (current cycle only, from high operator to low operator)
- 6 Feedback Path 1
- 7 Feedback Path 2
- 8 Feedback Path 3
- 9 Accumulator
- 10 Noise