TR-909 SERVICE NOTES *First Edition*

SPECIFICATIONS

Memory Capacity
48 Rhythm Patterns (16 x 3 Pattern Groups)
x 2 (Bank I, II)

Tracks
4 Tracks (1 to 4: Continuous Maximum measures 896)
x 2 (Banks I, II)

Steps (per measure)
1 to 16 steps

Tempo
♩ = 37 to 290

Rear Panel
Master Out (L, R/MONO) [6 Vp-p, 1kΩ]
Multi Out .....See P.9
Bass Drum, Snare, Low Tom, Mid Tom, Hi Tom,
Rim Shot, Claps, Hi-Hat, Crash, Ride

Trigger Out
(Rim Shot: + 14V, 20 ms pulse)

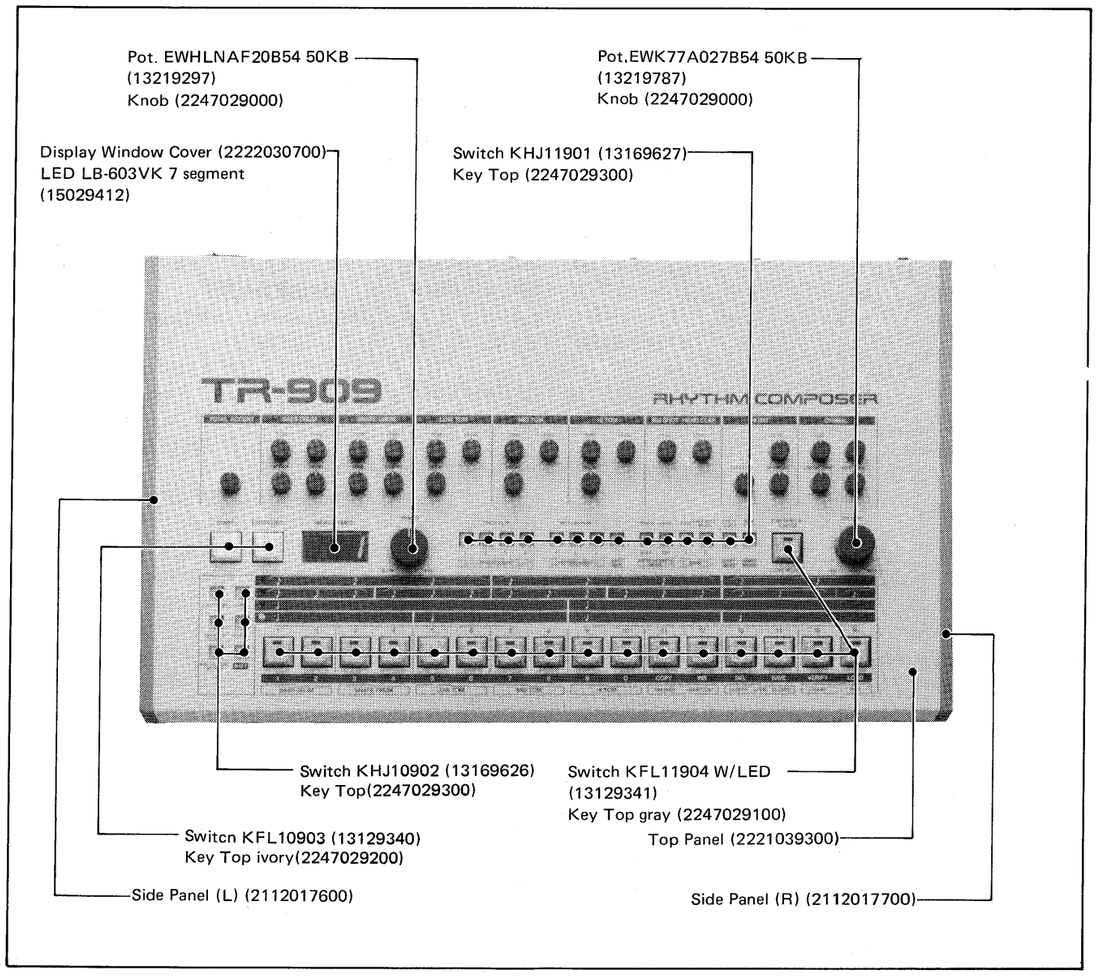
Sync In (5P-DIN)
(1: Run/Stop, 2: GND, 3: Clock, 5: Continue)

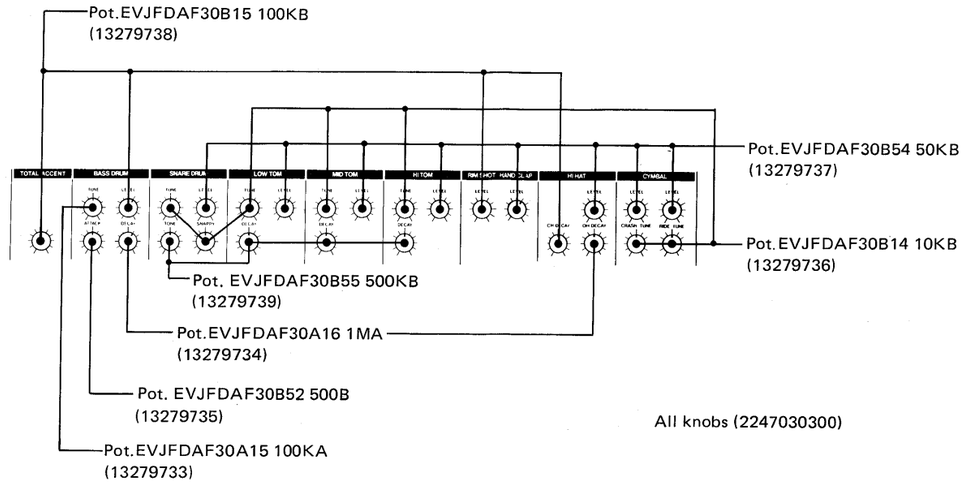
Power Consumption: 14W

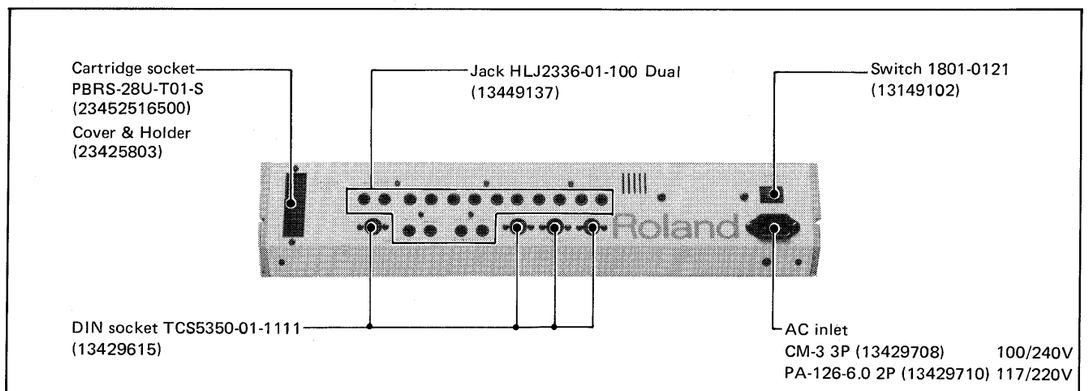
Dimensions:
486(W) x 105(H) x 300(D) mm/
19-1/8(W) x 4-1/8(H) x 11-13/16(D) in

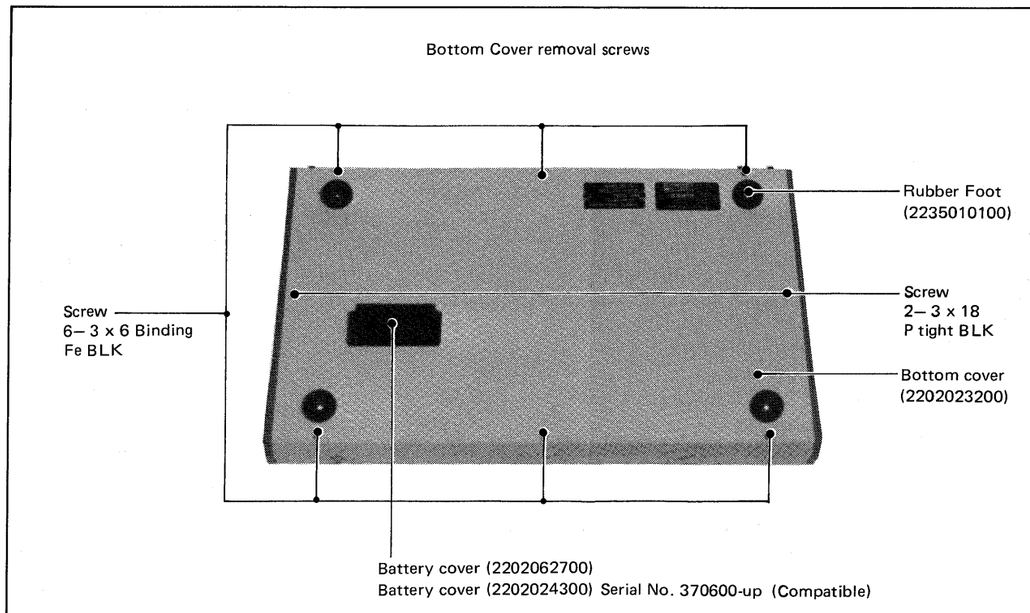
Weight: 4.5 kg/9 lb 15 oz

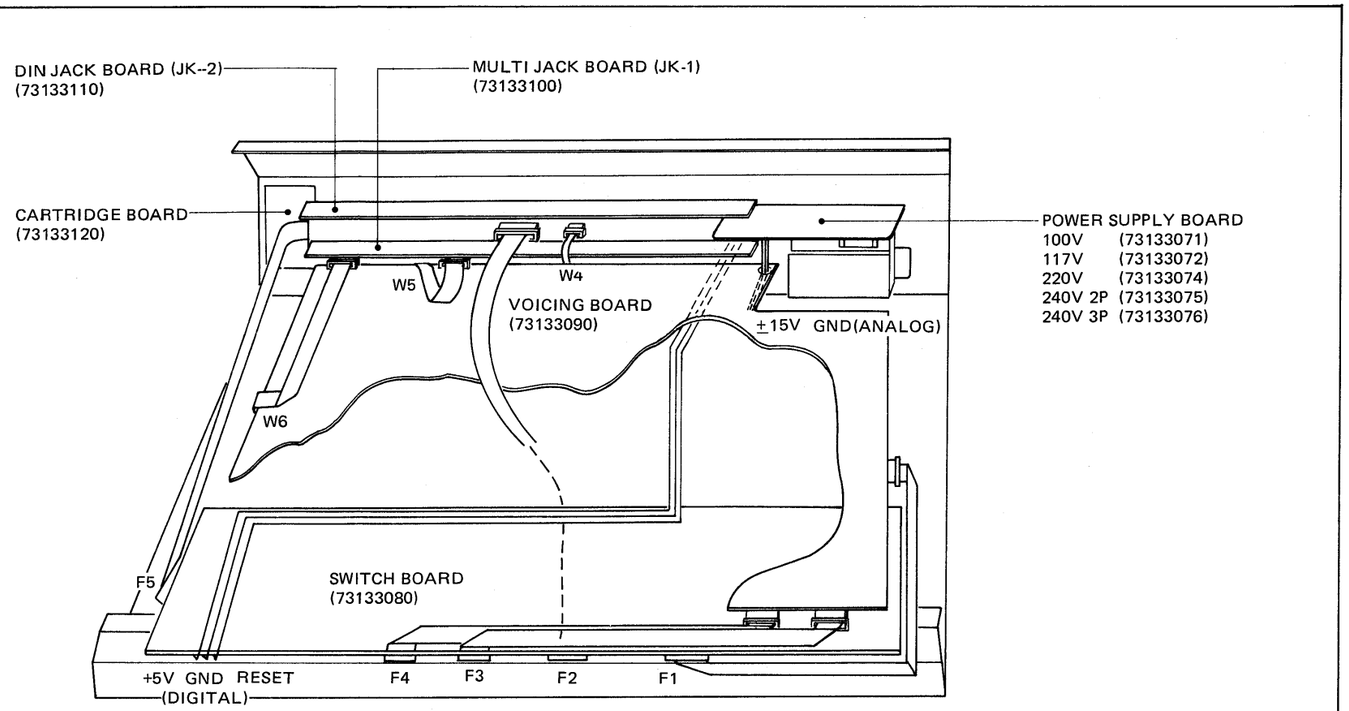
Option: Memory cartiridge M-64C
Pedal Switch DP-2











PARTS LIST

CASING

2221039300	Panel top	
2202023200	Cover bottom	
2112017700	Panel side (R)	
2112017600	Panel side (L)	
2202024300	Cover battery box	
2222030700	Cover display window	
2235010100	Rubber Foot	

KNOB, BUTTON, KEY TOP

2247029000	Knob	tempo, volume
2247030300	Knob	all small rotary knobs
2247029300	Button	light touch switch
2247029100	Key Top (gray)	
2247029200	Key Top (Ivory)	

PCB ASSEMBLY

73133071	Power Supply Board (pcb 2291084703 1/2)	100V
73133072	Power Supply Board (pcb 2291084703 1/2)	117V
73133074	Power Supply Board (pcb 2291084703 1/2)	220V
73133075	Power Supply Board (pcb 2291084703 1/2)	240V 2P
73133076	Power Supply Board (pcb 2291084703 1/2)	240V 3P
73133080	Switch Board (pcb 2291084703 2/2)	
73133100	Multi Jack Board JK-1 (pcb 2291084903 1/3)	
73133110	DIN Jack Board JK-2 (pcb 2291084903 2/3)	
73133090	Voicing Board (pcb 2291084903 3/3)	
73133120	Cartridge Board (pcb 2291085000)	

TRANSFORMER

22450364U0	Power	

FUSE, FUSE HOLDER

12559356	SGC-1A	100, 117V
12559509	CEE-T315mA	220, 240V
12199519	TF-758 Fuse Holder	

SOCKET, JACK

13429708	CM-3 AC Inlet 3P	100, 240V
13429710	PA-126-6.0 AC Inlet 2P	117, 220V
13429615	TCS5350-01-1111 DIN Socket	
13429166	HIF3FA-30P-2.54	CARTRIDGE BRD-SW BRD
2342516500	PBRS-28U-T01-S Socket 30P	MEMORY CARTRIDGE
13449137	HLJ2336-01-100	dual

CARTRIDGE SOCKET ACCESSORY

23425803	Cover and Holder	

SWITCH

13149102	1801-0121 (rocker)	power
13129341	KFL11904 (push) w/LED	
13129340	KFL10903 (push)	start, stop/cont
13169627	KHL11901 (light touch) w/LED	
13169626	KHL10902 (light touch)	

POTENTIOMETER

13219297	EWHLNAF20B54	50K(B)	tempo
13279735	EVJFDAF30B52	500(B)	attack
13279736	EVJFDAF30B14	10K(B)	
13279737	EVJFDAF30B54	50K(B)	
13279733	EVJFDAF30A15	100K(A)	
13279738	EVJFDAF30B15	100K(B)	
13279739	EVJFDAF30B55	500K(B)	
13279734	EVJFDAF30A16	1M(A)	
13219787	EWK77A027B54	50K(B)	volume
13299114	H1051A013	10K(B) trimmer	

IC

15179149	μPD7811G-033-036	NMOS CPU
15179645	M5M2764P-250NS-645	P-ROM
or 15179646	M5M2364P-250NS-646	MASK ROM
15179633	HN61256P-PC42	CMOS MASK ROM Crash
15179634	HN61256P-PC43	CMOS MASK ROM Hi-hat
15179635	HN61256P-PC44	COMS MASK ROM Ride
15179336	TC5565 PL-15	CMOS S-RAM
15159307	HD14511BP	CMOS BCD to 7-segment Latch/Decorder/Driver
15159140HO	HD14006BP	CMOS 18-bit Static Shift Register
15159103TO	TC4011UBP	CMOS Quadruple 2-input NAND Gate
15159105T1	TC4013BP	CMOS Dual D-Flip-Flop
15159141HO	HD14040BP	CMOS 12-bit Binary Counter
15159301TO	TC4520BP	CMOS Dual Binary Up Counter
15159116TO	TC4069UBP	CMOS Hex inverter
15159117HO	HD14070BP	CMOS Quadruple Exclusive-OR Gate
15159133HO	HD14174BP	CMOS Hex D-Flip-Flop
15169301HO	HD74LS00P	TTL Quadruple 2-input NAND Gate
15169318HO	HD74LS138P	TTL 3 to 8 Demultiplexer
15169331XO	SN74LS244N	TTL Octal Buffers
15169358HO	HD74LS373	TTL Octal D Latch
15169327HO	HD74LS367AP	TTL Hex Bus Drivers
15169324XO	SN74LS245N	TTL Octal Bus Tranceivers
15189136	M5218L	OP Amp
15189113	AN6912	Quad Comparator
15229802	BA662A	Vari-conductance Amp
15229712	PC-900	Photo Coupler
15199106	UA7805UC	V RGL +5V
15199105	UA7815	V RGL +15V
15199102	UA7915	V RGL -15V
15149110	M54562	Transistor array
15149113	M54516	Transistor array

TRANSISTOR

15119108	2SA798-G	PNP
15119125	2SA1115-28-F	PNP
15129137	2SC2603-28-F	NPN
15129136	2SC2878-A or B	NPN
15129612	2SD1469-R	NPN

DIODE

15019245	1B4B41	rectifier bridge
15019305	RD6.8JB2	zener
	RD5.6JB2	zener SW board
15019125	1SS-133	
15019126	1SS-133T-77	
15019661	RD18JB2-T	zener

LED

15029412	LB-603VK	7-segment
15029140	SEL102R	

CRYSTAL

12389717	12.00MHz

RESISTOR ARRAY

13919143	RGSD8x102-720	1K x 8
13919133	RM-0621	

CONNECTOR

13439133	5046-06A (MOLEX)	VOICING board
13439135	5046-09A (MOLEX)	VOICING board
13439136	5046-10A (MOLEX)	VOICING board
13439130	5046-3A (MOLEX)	DIN JACK board

AC CORD SET

13439816FO	DC-357-J01	100V
13439812FO	UC-704-J01	117V
13439813FO	EC-210-J06	220V 2P
13439817FO	EC-702-J05	240V 2P
13439814FO	SC-415-J06	240V 3P

WIRING ASS'Y

2341044001	10P	SWITCH board
2341044201	9P	SWITCH board
2341044300	30P	SWITCH board
2341044100	6P	VOICING board
2341043500	3P	VOICING board
2341043700	10P	VOICING board

OTHERS

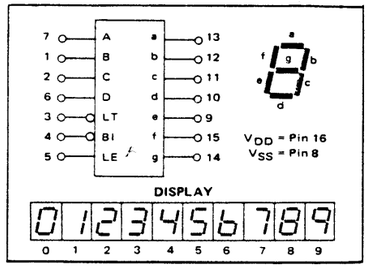
12469117	Heat Sink MT-25-BS	IC703 PS board
12469116	Heat Sink MT-50-BS	IC701,702 PS board
12199414	Battery Holder	
2219044200	Battery Box	
2219044600	LED Holder	
2219041000	Holder	MULTI JK Board
2219041100	Holder	DIN JK Board
13419206	Battery Snap T-250L	
2226034900	Cushion LED segment cover	
2224052400	Switch Mask A (375x27 mm)	
2224052500	Swtich Mask B (27x27 mm)	

COMMERCIALLY AVAILABLE ACCESSORIES

12569105	Battery UM3G	1.5V
2343067500	Connection Cable	LP-25

IC DATA

HD14511BP
BCD-TO-7SEGMENT LATCH/DECODER/DRIVER

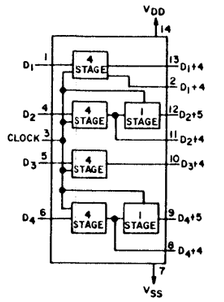


TRUTH TABLE

INPUTS							OUTPUTS							
LE	$\overline{BI}$	$\overline{LT}$	D	C	B	A	a	b	c	d	e	f	g	DISPLAY
X	X	0	X	X	X	X	1	1	1	1	1	1	1	8
X	0	1	X	X	X	X	0	0	0	0	0	0	0	Blank
0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	0	1	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	1	0	0	0	0	0	0	0	Blank
1	1	1	X	X	X	X				*				*

X = Don't Care
*Depends upon the BCD code previously applied when LE = 0

HD14006BP
18-BIT STATIC SHIFT REGISTER



TRUTH TABLE FOR SHIFT REGISTER STAGE

D	CL▲	D + 1
0	⌐	0
1	⌐	1
X	⌐	NC

1 = HIGH X = DON'T CARE
0 = LOW ▲ = LEVEL CHANGE
NC = NO CHANGE

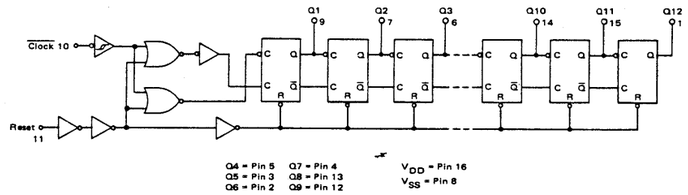
HD14040BP
12-BIT BINARY COUNTER

TRUTH TABLE

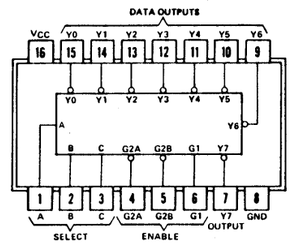
CLOCK	RESET	OUTPUT STATE
⌐	0	No Change
¬	0	Advance to next state
X	1	All Outputs are low

X = Don't Care

LOGIC DIAGRAM



HD74LS138P
3 TO 8 DEMULTIPLEXER

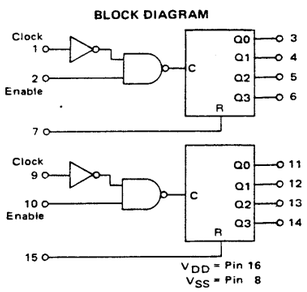


INPUTS					OUTPUTS							
ENABLE		SELECT										
G1	G2*	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	H	L	H	H	H	H
H	L	H	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	H	L	H	H
H	L	H	H	L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

*G2 = G2A + G2B

TC4520BP
DUAL BINARY UP COUNTER

BLOCK DIAGRAM

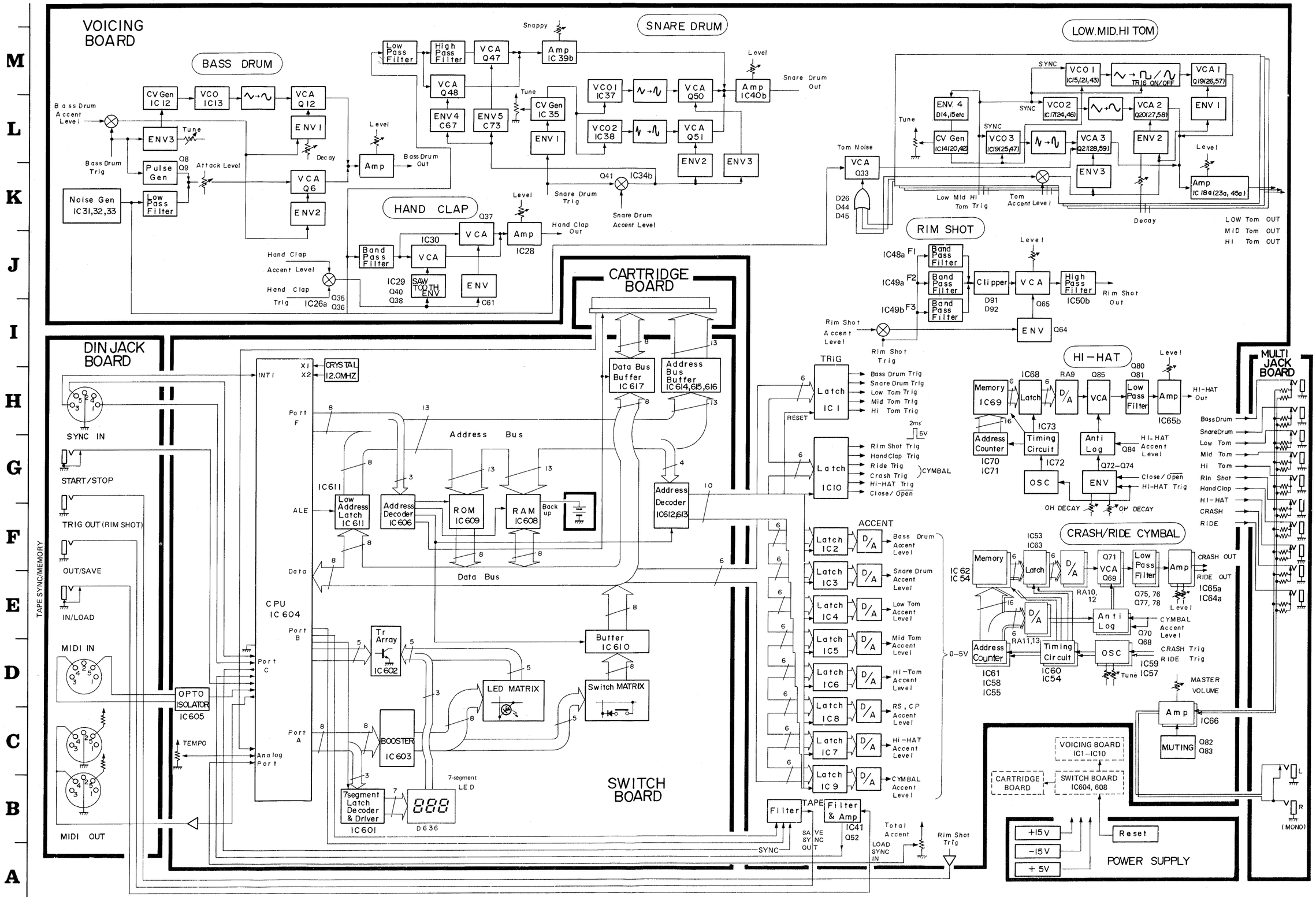


TRUTH TABLE

CLOCK	ENABLE	RESET	ACTION
⌐	1	0	Increment Counter
0	¬	0	Increment Counter
¬	X	0	No Change
X	⌐	0	No Change
⌐	0	0	No Change
1	¬	0	No Change
X	X	1	Q0 thru Q3 = 0

X = Don't Care

BLOCK DIAGRAM



CIRCUIT DESCRIPTIONS

IC604 CPU μPD7811G-033-036 (SWITCH BOARD) PORT ASSIGNMENT

PA	0–4	Scanning Signal Outputs to Switches
	5–7	LED Driving Signal Outputs
PB	0–4	Scanning Signal Outputs to LED
	5	Latch Signal Output to 7-seg LED Driver
	6–7	Data Outputs to Tape Interface
PC	0	Serial Transmitter to MIDI
	1	Serial Receiver from MIDI
	2	Input from Foot Switch
	3	Data Input from Tape Interface (Rhythm or SYNC data)
	4	Tape SYNC Output
	5	Start/Stop Signal Input from DIN Socket
	6	Continue Signal Input from DIN Socket
	7	Unused (Input)
PD	0–7	Data Bus Multiplexed Address Bus (Lower)
PF	0–7	Address Bus (Higher)
NMI		Unused
INT 1		Clock Signal Input from DIN
AN	0	Analog Voltage Input from TEMPO Control
	1–2	Unused
	3	Analog Voltage Input from TOTAL Control
	4–7	Unused

The TR-909 combines Voice Generators and CPU based controller. In basic operation, the CPU scans panel switches, stores switch outputs, and generates trigger (TRIG) and volume (ACCENT) data for the voice generators which are categorized into two: Digital and Analog. The CPU provides them with TRIG and ACCENT data in an identical way.

ACCENT & TRIG

ACCENT

Accent data on the CPU bus is latched into one of ACCENT latches (IC2-IC9) selected by Address Decoder (IC612, 613). Latched ACCENT code is converted to analog equivalent at the output of associated resistor array RM0621. The voltage is clamped to the level until it is replaced by the next incoming data.

TRIG

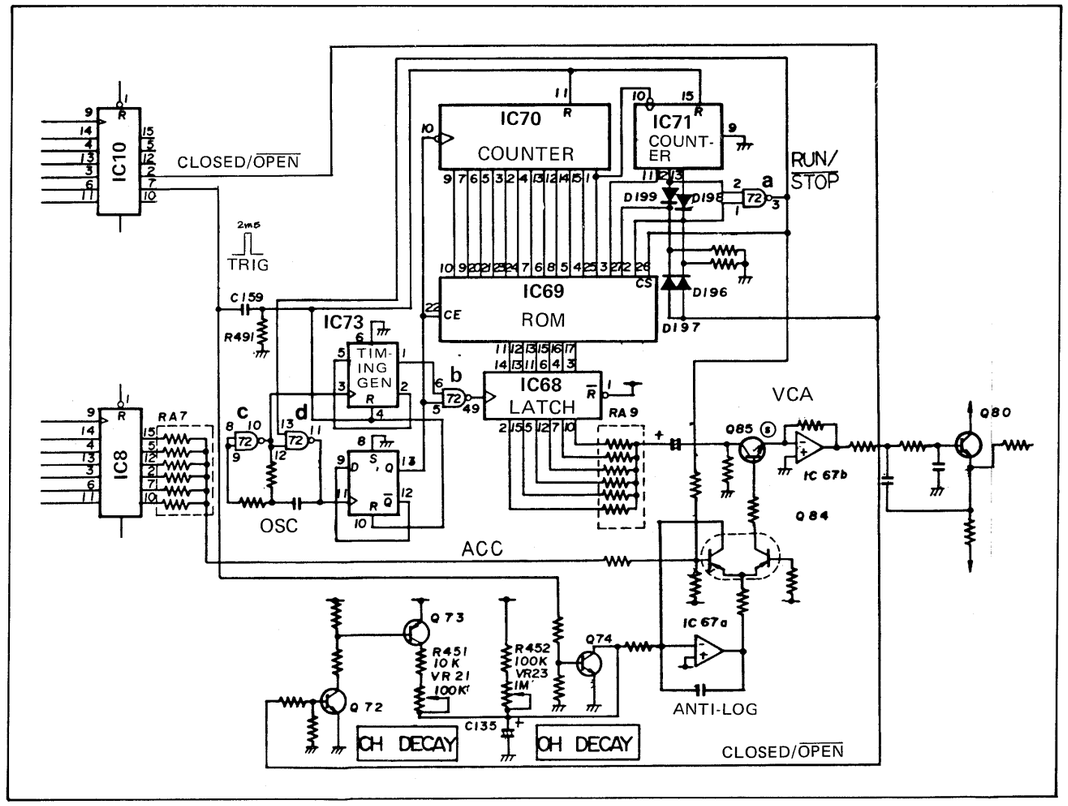
Almost concurrent with ACCENT, TRIG is latched into IC1 or IC10, and appears as 5V positive going pulse on the correct output pin for 2ms. TRIG is used either solely or in combination with ACCENT to reset generator(s) and to create various envelopes for controlling pitch, tone color, contour, loudness, etc. of the particular rhythm sound being sounded.

DIGITAL VOICE GENERATORS

Hi-Hat, Ride and Crash cymbals are reproduced out of digital sound memories which have been sampled from an actual instrument, modified to be useful as data and stored into the ROM by way of PCM.
Circuit configurations and operations of these voices are basically the same. The following description takes Hi-Hat as a representative.

HI-HAT

Pressing Hi-Hat button(s) develops a positive pulse (TRIG) on pin 7 of IC10, resetting Address Counters IC70 and IC71 to have "0's" on their all outputs. These 0's cause IC72a output to swing to H(run) irrespective of a CLOSED/$\overline{\text{OPEN}}$ being applied to diode OR's (D196–199).



Upon receiving this "run" from IC72a, a combination of two gates (IC72 c and d) starts oscillation and outputs about 60kHz, which is divided by two and shaped up by IC73 flip-flop (TIMING GEN), clocking the address counters. With the same bits applied from the address counters, a logic (D196 – 199 OR gates) places ROM beginning and end at different locations according to H or L of the CLOSED/$\overline{\text{OPEN}}$ as shown in the table. IC72a turns its output to L (stop) when the counter increments to:

110 0000 0000 0000 . . . . in $\overline{\text{OPEN}}$ mode
010 0000 0000 0000 . . . . in CLOSED mode

ADDRESS TABLE

OPEN HI-HAT	000 0000 0000 0000 ↓
COMMON ADDRESS	110 0000 0000 0000 ↓
CLOSED HI-HAT	111 1111 1111 1111

Voice data clocked out of ROM IC69 are latched into IC68 and then converted to analog voltages while passing through RA9. The sound results at RA9 output has an evelope somewhat different from that of actual Hi-Hat sound. This is because the Hi-Hat sounds have been compressed before being digitalized and Pulse Code Modulated (PCM) in order to have greater S/N ratio and higher digital resolution. The envelope of this Hi-Hat sound can be controlled manually with DECAY control (VR21 or VR23).

CLOSED . . . . . A high CLOSED/OPEN on Q72 base removes a positive voltage from its collector which in turn allows Q73 to charge DECAY capacitor C135 through R451 and VR21. Since this charging path is 1/tenth the total resistance of R452 and VR23, the charging rate of C135 depends on VR21 setting.

OPEN . . . . . With low CLOSED/OPEN, CH charging path is disconnected from the DC supply source at Q73 OH path becomes conductive.

CRASH & RIDE

These voices also have unique envelopes that are quite different from actual sounds when the data are directly reproduced. The reason is the same as described in Hi-Hat section. Restoration of the envelops are made by the use of ROM addresses as the envelop data.
Before being stored into the ROM, the envelope of CRASH is changed with the following conpensation measure taken into consideration. When CRASH sound data are read successively from ROM (IC62) with correct addresses, the same addresses are also converted to analog voltages through RA11, anti-log tapered by IC52b and Q70, and are applied to the base of Q71 (VCA) which is configured as a voltage controlled potentiometer to give the incoming voltage the CRASH decay curve.

ANALOG VOICE GENERATORS

SNARE, BASS, TOM TOM operate basically in the same manner and share the same Noise Generator. For discussion purposes the schematic references for SNARE DRUM are used in the description below.

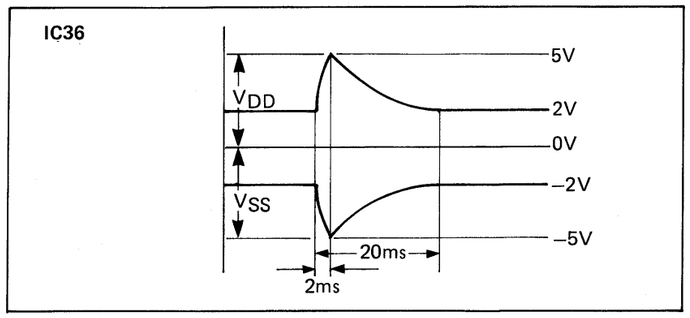
SNARE DRUM

SNARE DRUM consists of Drum and Snappy, each further separated into two parts.

DRUM

Drum voice is composed of VCO-1 and VCO-2 with associated Control Voltage Generator (IC35). VCO-1 and VCO-2 have similar circuitry except that charging capacitors C69 and C71 have different capacitance so that they can oscillate at different frequency: VCO-1 runs at lower frequency.
VCO-1 comprises a hytheresis comparator IC37a, inverting buffers configured as voltage-dependent resistor (in IC36) and an integrator consisting of IC37b and C69 with Q44 switcher. In this arrangement VCO-1 generates triangle waveform. When TRIG is applied to the base of Q39 VCO-1 receives a positive pulse from Q40 collector at the following places.

a) One input of IC37a via D62. When the pulse is applied, IC37a turns its output to low.
b) The base of Q44 which discharges C69, canceling VCO-1 output.
The combination of a) and b) resets VCO-1 to the starting point at which VCO-2 also starts oscillation, phasing the initial waveforms of both VCOs.
c) The base of Q46 which cuts off VCA Q50, muting unwanted noises in the VCO-1 path.
d) VCO-1 also sees the effects of trigger pulse from Q40 at V_{DD} and V_{SS} terminals of buffer IC36 through the control voltage generator.
The outputs of IC35 gives the buffers output amplitude proportional to ENV-1 as shown in figure; the charging rate of C69 also continuously changes for about 20ms. The resultant effect is a pitch bend of Snare drum sound for that period.
The amount of drum voice from VCO-1 is determined by VCA Q50 whose gain follows ENV 3 which is in turn controlled by an ACCENT coming through Q4 currently gated by the TRIG.



SNAPPY

ACCENT signal is gated through Q41 by the trigger from Q39 collector and is coupled to the base of Q47 VCA as ENV 5. ENV 5 determines the amount of high frequency noise components in the SNAPPY which becomes articulate when noises passing through a high pass filter (IC39a and associated RC's) are combined with the noises from the low pass filter at IC39b.

NOISE

This is a quasi-random noise generator having two shift registers (IC32, IC33) connected in cascade making up 32 stages. Chaining of 32 stages provides a longer interval between the beginning and the end of shift cycles. This means that the frequency changes occuring at end/start points of shifting cycle are made less noticeable to the human ear. Two Ex-OR gates of IC31 clock the shift registers at a higher frequency, allowing them to create noises that contain favorable higher frequency contents.
On power-up, a trigger is applied into pin 1 of IC32 via D48 for starting running.

RESET

Q701, Q702, D701 and associated circuits on the Power Supply Board cause RESET inputs to IC604 CPU and IC608 RAM on Switch Board to be held low on power-up to allow DC supplies and signals to stabilize before starting processing. When the voltage on input terminal of IC703 (Power Supply Board) reaches 7.0V, Q701 conducts and cuts off Q702. The circuit also provides power down reset when the IC703 input voltage goes sufficiently below 7.0V on power down or power fail. The RESET is also routed to:
Cartridge Board and
TRIG and ACCENT latches (IC1–IC10) on VOICING Board via Switch Board. When the unit is operated from a poor AC line and is forced to stop or reset, first check the unit's serial number. If prior to 393000, replace D701 (zener diode) of Power Supply Board with RD5.6JB2. Refer to "CHANGE INFORMATION" in this manual.

TAPE INTERFACE

TAPE INTERFACE on VG BRD consists of two sections: Output-to-TAPE and Input-from-TAPE. The Interface will take dual duties; either a) or b) described below depending on TR-909 operation mode.

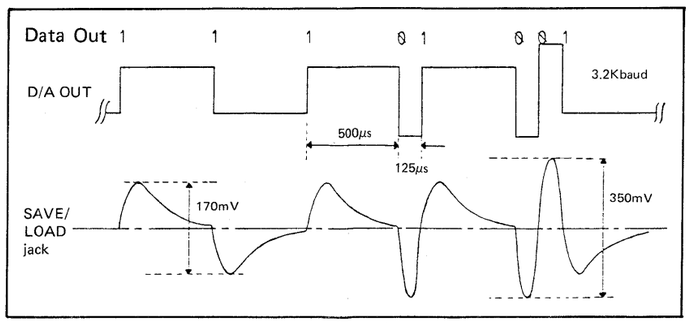
a) MEMORY SAVE & LOAD
To allow rhythm data stored in TR-909's memory to be preserved on cassette tape recorder and vice versa.
b) TAPE SYNC
To allow a signal (TEMPO CLOCK) on a tape to control the speed of operation of TR-909. Also to provide such sync signal for recording on tape.

In normal PLAY mode TAPE INTERFACE sends out TAPE & SYNC signal from OUT/SAVE jack.
In basic WRITE mode TR-909's CPU does not accept data coming through the Interface.

SAVE & LOAD/VERIFY

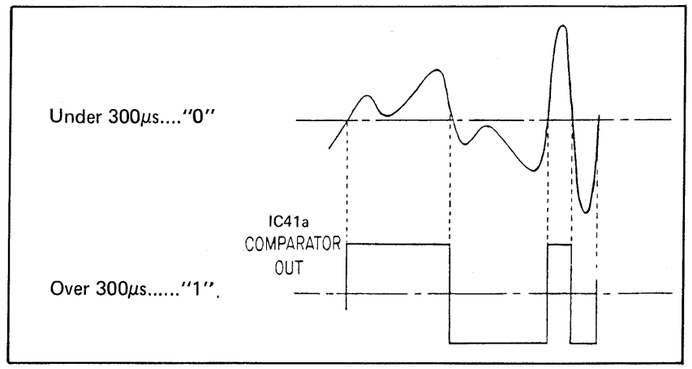
SAVE

During SAVE routine, the CPU (on SW BRD) represents rhythm data, which is to be recorded on tape, as 2-bit code on Port B- 6 and 7. CPU can select one of two codes for one "0", and another one of two for each "1" to make successive 1's and 0's distinguishable from the adjacents when they are chained at the output of D-to-A arrangement composed of R318-R322.



LOAD & VERIFY

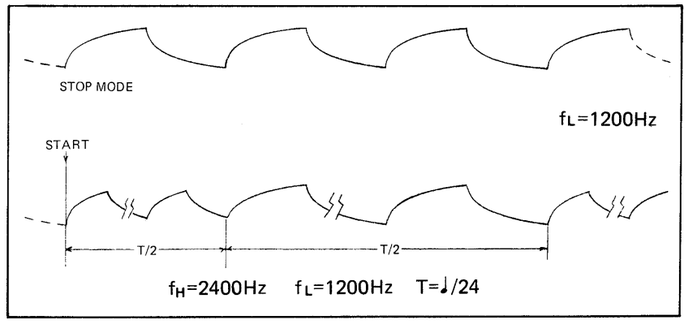
Rhythm data from tape passing through IN/LOAD jack is first differentiated, smoothed at IC41b, shaped up to a rectangular at IC41a comparator, then entered into the CPU via Port C-3. The CPU measures the length of each incoming half-period by detecting every edge. Depending on the length the CPU recognizes a "0" or a "1" as follows:



TAPE SYNC

IN STOP MODE . . . The CPU develops continual 1200Hz pulse at Port C-4;

IN normal PLAY MODE . . .The CPU generates 1200Hz and 2400Hz alternately.
The CPU changes frequency between 1200 and 2400Hz at every half-period of T which is 1/24 of the time required for most of Roland products to process a quarter note.
These 1200 or/and 2400Hz coming to TAPE INTERFACE have their high components filtered out by C93, R328, C94 and R329 before being routed to OUT/SAVE jack for use by the tape recorder as shown below.



IN SYNC-TO-TAPE MODE . . . IC41, Q52 and surrounding circuits work on incoming signal in just the same way they do in LOAD or VERIFY mode.
The CPU converts this signal to the actual useful information. That is, the number of times per second that the signal changes frequency between 1200 and 2400Hz.

RELOADING FACTORY-PATTERNS

1. The TR-909 contains factory-rhythm patterns in BANK I, TRACK 1 under as-delivered condition. When the need arises to reload the patterns, follow the procedure below.

Note: Confirm that the resident voice data (especially, user's program) allows replacing.

While holding down TRACK 1 and PATTERN 1, turn the unit ON.

2. RE-LOADING BANKs I, II, TRACK 4
(See "Change Information" No. 1 in the subsequent paragraph to decide whether the following steps are necessary.)
1) While depressing SHIFT, tap TRACK 4.
2) Tap ENTER.
3) Depress TRACK 4.
4) While depressing SHIFT, tap BANK II.
5) While depressing SHIFT, tap TRACK 4.
6) Tap ENTER.

CHANGE INFORMATION

ROM IC609 SWITCH BOARD

GROUP	SERIAL NUMBER	ROM USED	REMARKS
A	360100 393899	2764-250NS (Revision 0)	without version number on the label EPROM Part Number 15179645
B	403900	2764-250NS (Revision 1) or 2364-250NS	with version number Ver. 1 on the label both contain the same program MASK ROM Part Number 15179646

Description

ROM in Group A

If measures in TRACK 1, 2 or 3 are incremented or decremented while there is no measure in TRACK 4, and one of subsequent TRACKs is selected for writing, all rhythm patterns may be lost or re-written. This can be avoided by implementing "RELOADING FACTORY-PATTERNS" paragraph 2 in the preceding section, or by replacing the existing ROM with the one in Group B.

ROMs in Group A and B

When synchronizing to MIDI clocks, there are glitches. TR-909 sometimes falls behind if STOP is pressed, then CONTINUE is pressed (this won't happen when MIDI clocks are transferred between TR-909's). Software revision 2 cures this problem and is incorporated in 2764-250NS labeled Ver. 2. To check if existing ROM is Ver. 2, turn the power ON while holding down TRACK 1 key, and MAIN key 2 (BASS DRUM) will blink, if version 2. ROMs of Ver. 2 are available from the factory to upgrade units on the market.

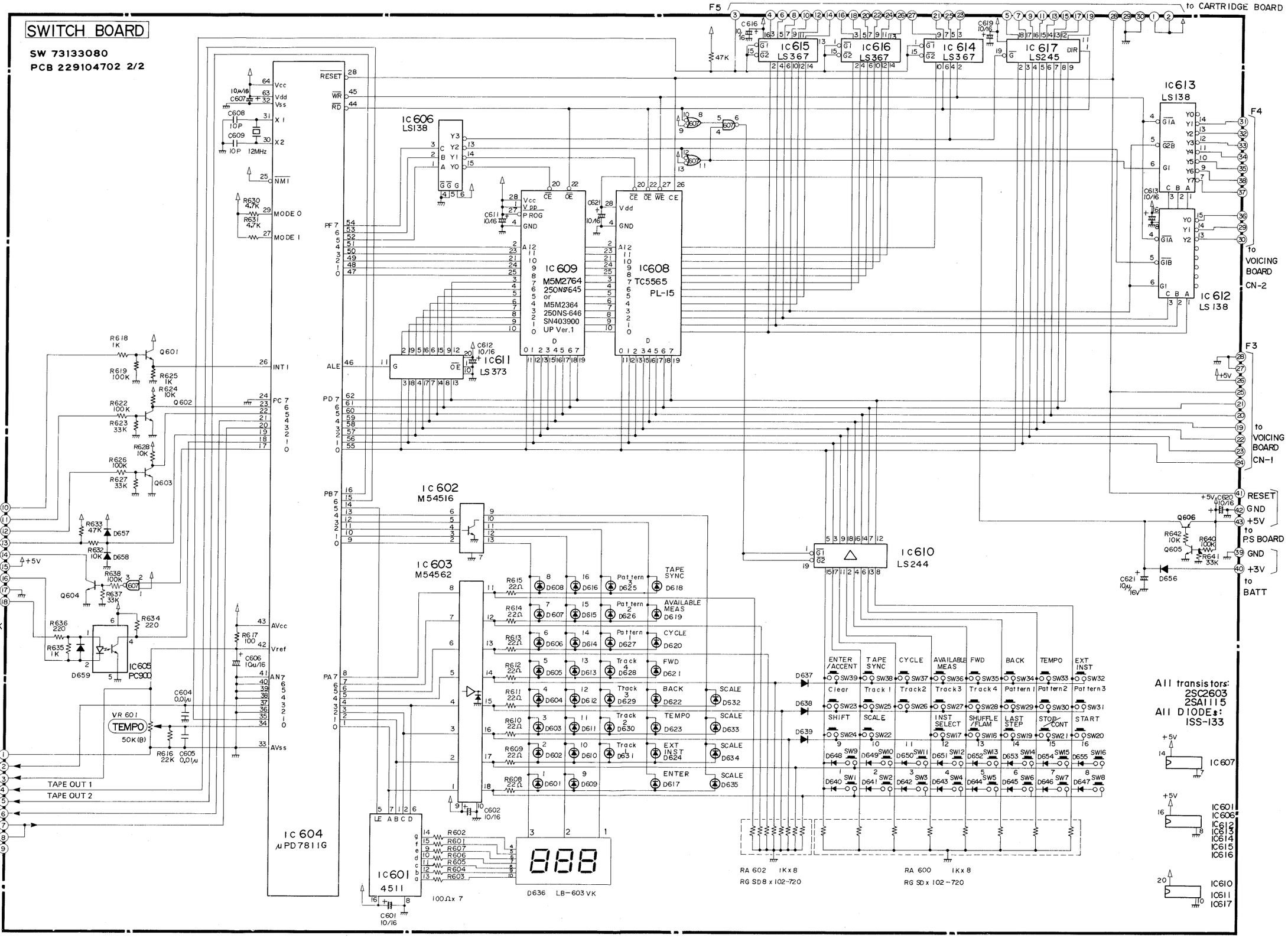
SERIAL NUMBER	PART AFFECTED	DESCRIPTION
370600	Battery Compartment Lid	From rubber-made to metal-made. For positive engagement. As a replacement Metal one should be used (compatible).
381500	TAPE SYNC Filter & Amp VOICING BOARD	C87. From 10pF to delete. R306. From 4.7k to 47k. R312. From 470k to 4.7M. For optimizing waveforms coming from tape in LOAD mode.
	BASS DRUM VOICING BOARD	Capacitor C9. From 0.22μF to 0.33μF. For expanding the TUNE range.
393000	RESET POWER SUPPLY BOARD	D701. From RD6.8JB2 to RD5.6JB2. TR-909 would be forced to stop or its LED would start blinking when high power electrical instrument(s) is powered ON or OFF under poor AC supply condition (about less 10% nominal voltage). This simple diodes change will ensure reliable operation even at 20% below the nominal voltage.
415300	RIM SHOT VOICING BOARD HI-HAT VOICING BOARD	Resistor R417. From 12k to 3.3k. For giving the voice more realistic sound. Capacitor C134. From 10μF to 0.01μF. For rolling off unnecessary lower frequencies.
	RIM SHOT/TRIG OUT (TAPE SYNC) VOICING BOARD DIN JACK BOARD (JK-2)	From jumper wire to R495 1k. R393. From 10k to 1M. R392. From 22k to 1M. Add capacitor C600 0.1μF between terminal No. 30 and the ground (TRIG OUT jack -- Hot-Ground). For preventing RIM SHOT signal from being induced onto TAPE SYNC signal which otherwise may cause glitches.
426700	TOM Noises VOICING BOARD	Capacitor C54. From 0.0022μF to 0.0047μF. R194 47k to 100k. This change will emphasize attack of TOM TOMs.

FAULT ISOLATION GUIDE

Symptom	CAUSE & ACTION TO BE TAKEN
The Unit fails to reproduce programmed rhythm sequence. Some memories have been replaced by other data.	PROM IC609 Ver. 1.0 has new program which should solve the problem of unreliability. Refer to "CHANGE INFORMATION" Check DC rails. Check IC702 on the Power Supply Board. Check RA600 and RA602 on Switch Board.
The unit stops running upon power ON/OFF transient of other electrical devices.	RESET circuitry is too sensitive to AC power drop. Check zener diode D701 on Power Supply Board. If it is RD6.8JB2, replace with RD5.6JB2. Refer to "CHANGE INFORMATION"
Data transfer between Internal Memory and Memory Cartridge (SAVE/LOAD) fails.	There should be an additional instruction to "3. Memory Cartridge" of the Owner's Manual (p.33). ENTER KEY must be UNLIT (Internal Memory Mode) during SAVE or LOAD from Memory Cartridge. That is . . ."Press ENTER when it is lit, then hold SHIFT."
Noise is high in OUTPUT	For the units prior to Serial Number 415300. Add capacitor 0.01μF across jack circuits on Multi Jack Board (MULTI JACK BOARD Diagram denotes these capacitor as C500–C512).

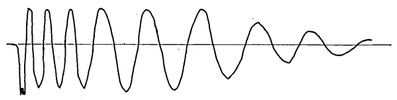
SWITCH BOARD

SW 73133080
PCB 229104702 2/2

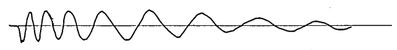


Observed at MULTI OUT jack with all knobs set to center.

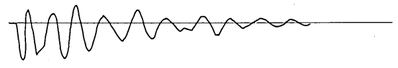
BD
200mV/div
5ms/div
with accent



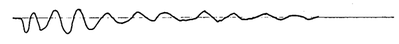
w/o accent



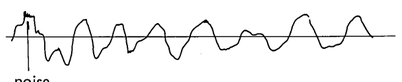
SD
0.5V/div
2ms/div
with accent



w/o accent



LT
0.5V/div
with accent

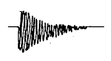


w/o accent

50ms/div

LT with accent

MT, HT with accent



RS
2ms/div

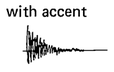
R417=3.3K

R417=12K

HAND CLAP
500mV/div
10ms/div

HI-HAT
CLOSED
500mV/div
20ms/div

with accent



w/o accent

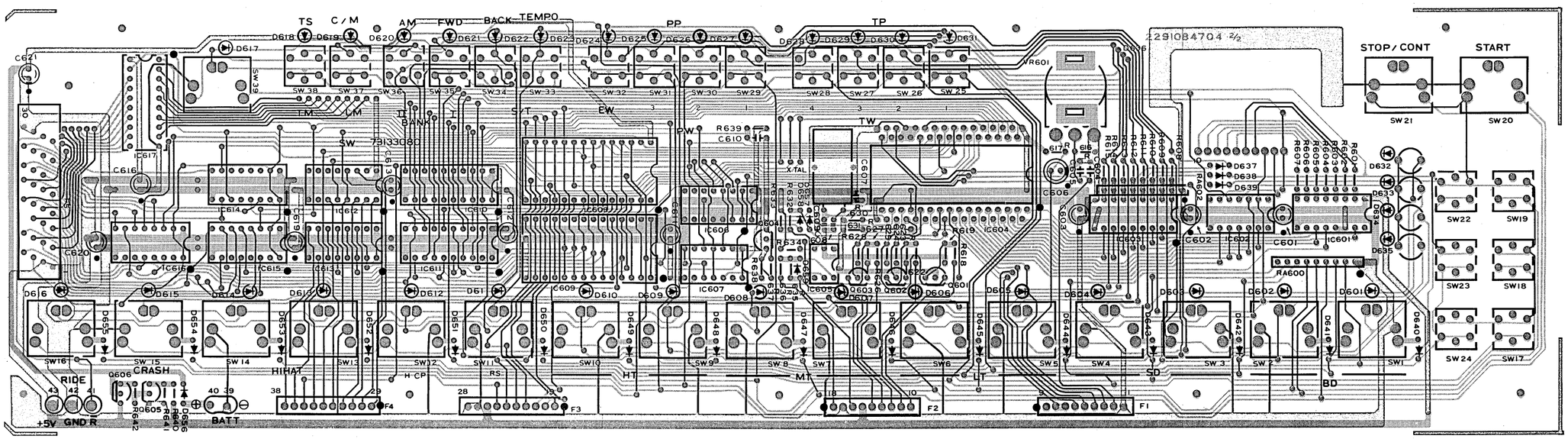
OPEN
500mV/div
0.1s/div

CRASH
500mV/div
0.1s/div

RIDE
500mV/div
0.1s/div

SWITCH BOARD
73133080
(pcb 2291084701 2/2)

View from foil side



CIRCUIT DIAGRAM ADDRESS MAP

NOTE: On early PCBs two Q-40's exist one of which is denoted as Q-86 on later PCBs.

IC

IC1 M-3
IC2 K-3
IC3 I-3
IC4 H-3
IC5 G-3
IC6 F-3
IC7 E-3
IC8 D-3
IC9 B-3
IC10 L-3
IC11 a M-12
b M-6
IC12 a N-8
b N-9
IC13 a M-10
b M-11
IC14 a R-19
b Q-19
IC15 a R-20
b R-21
IC16 R-20,R-23, R-25
IC17 a R-24
b R-26
IC18 a Q-25
b Q-20
IC19 a R-22
b R-23
IC20 a N-19
b M-19
IC21 a N-20
b N-21
IC22 N-20,N-23, N-25
IC23 a M-25
b M-20
IC24 a N-24
b N-26
IC25 a N-22
b N-23
IC26 a J-11
b G-13
IC27 a N-16
b M-15
IC28 a H-16
b
IC29 a I-12
b J-12
c J-12
d J-13
IC30 H-15
IC31 a K-15
b K-15
c M-15
d L-14
IC32 L-15
IC33 L-16
IC34 a Q-2
b R-2
IC35 a P-3
b P-3
IC36 P-5,P-9
IC37 a P-4
b P-6
IC38 a P-8
b P-10
IC39 a Q-6
b R-7
IC40 a Q-5
b R-12
IC41 a Q-14
b Q-15
IC42 I-19
IC43 a J-20
b J-21
IC44 J-20,J-23,J-25
IC45 a H-26
b I-20
IC46 a J-24
b J-26
IC47 a J-22
b J-23
IC48 a J-7
b J-6
IC49 a I-7
b H-7
IC50 a J-9
b J-10
IC51 a C-24
b C-17
IC52 a E-24
b E-17
IC53 D-21
IC54 E-21
IC55 F-22
IC56 a E-19
b F-19
IC57 a F-18
b F-18
c F-18
d E-20
IC58 a F-15
b F-21
IC59 a F-13
b E-11
c E-11
d F-11
IC60 a E-12
b F-12
IC61 F-14
IC62 D-14
IC63 D-14
IC64 a D-26
b unused
IC65 a C-20
b C-12
IC66 a A-25
b B-25
IC67 a B-8
b C-9
IC68 D-7
IC69 E-6
IC70 F-8
IC71 F-6
IC72 a E-8
b D-6
c D-5
d D-5
IC73 a D-5
b C-5

TR

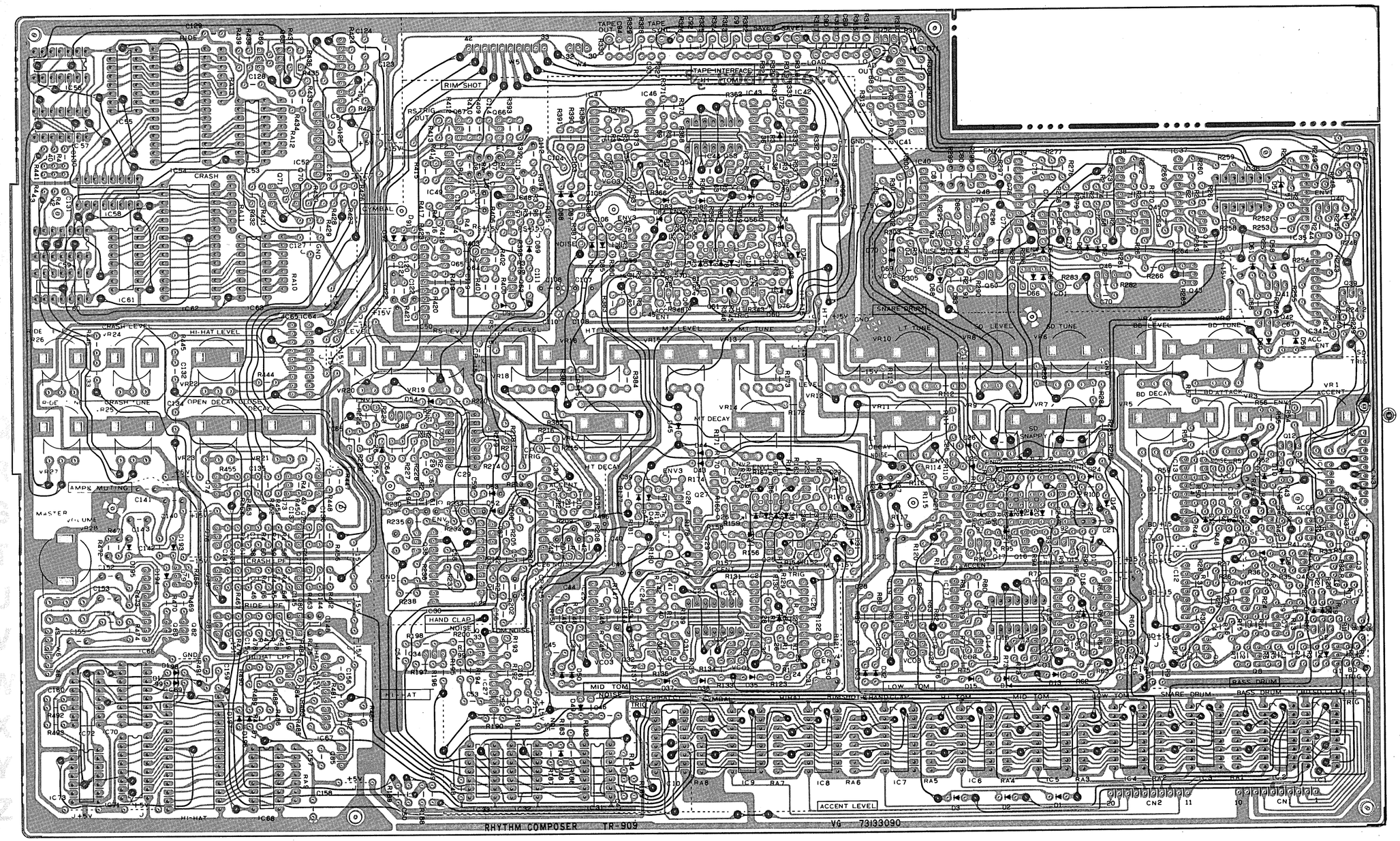
Q1 N-6
Q2 N-7
Q3 L-7
Q4 L-7
Q5 M-7
Q6 L-10
Q7 N-7
Q8 M-8
Q9 M-9
Q10 M-9
Q11 N-10
Q12 M-12
Q13 R-21
Q14 R-25
Q15 P-21
Q16 O-20
Q17 P-20
Q18 Q-21
Q19 Q-22
Q20 P-25
Q21 P-23
Q22 R-23
Q23 M-21
Q24 L-21
Q25 L-20
Q26 L-22
Q27 L-25
Q28 L-23
Q29 L-20
Q30 N-21
Q31 N-25
Q32 N-23
Q33 N-16
Q34 N-15
Q35 I-11
Q36 J-11
Q37 H-15
Q38 J-15
Q39 P-2
Q40 Q-2,I-14(Q86)
Q41 R-2
Q42 R-3
Q43 Q-7
Q44 P-5
Q45 P-10
Q46 Q-9
Q47 R-7
Q48 R-5
Q49 Q-12
Q50 R-9
Q51 R-12
Q52 R-14
Q53 J-21
Q54 J-25
Q55 J-23
Q56 I-21
Q57 H-22
Q58 H-25
Q59 H-23
Q60 H-21
Q61 G-20
Q62 H-20
Q63 I-6
Q64 J-7
Q65 J-8
Q66 H-9
Q67 H-9
Q68 E-24
Q69 D-24
Q70 E-17
Q71 C-17
Q72 Q-5
Q73 B-6
Q74 B-7
Q75 C-19
Q76 C-20
Q77 D-26
Q78 D-26
Q79 B-25
Q80 D-10
Q81 D-11
Q82 A-27
Q83 A-26
Q84 C-8
Q85 D-8
Q86 I-14(Q40)

VR

VR1 S-17
VR2 M-8
VR3 L-10
VR4 M-12
VR5 M-11
VR6 P-1
VR7 R-3
VR8 R-12
VR9 S-7
VR10 R-18
VR11 P-25
VR12 Q-26
VR13 N-18
VR14 L-26
VR15 M-26
VR16 J-18
VR17 H-26
VR18 I-26
VR19 J-9
VR20 H-16
VR21 B-6
VR22 D-12
VR23 B-7
VR24 C-20
VR25 E-11
VR26 E-26
VR27 E-27
VR28 B-26

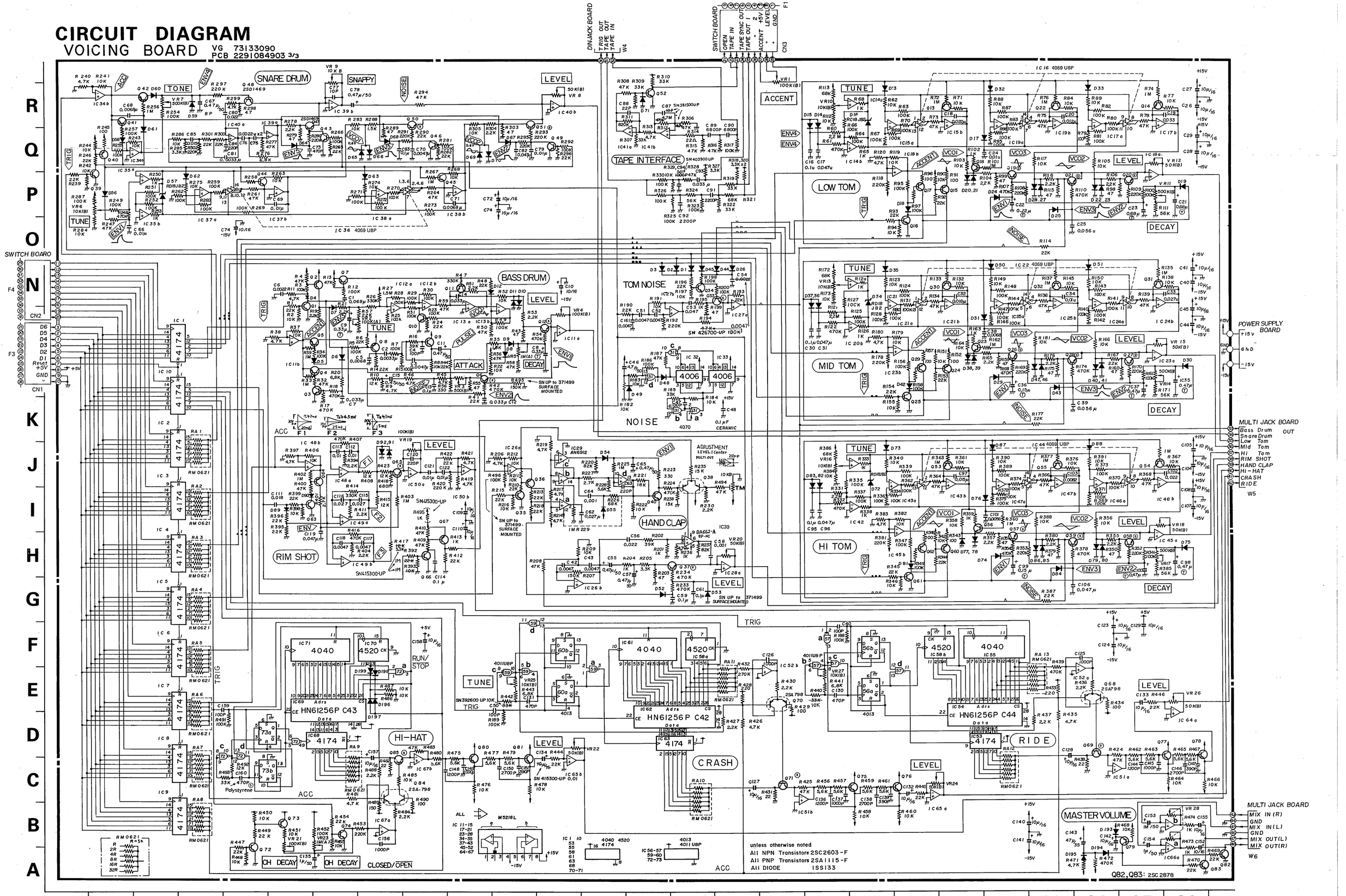
VOICING BOARD 73133090 (pcb 2291084900 3/3)

View from foil side

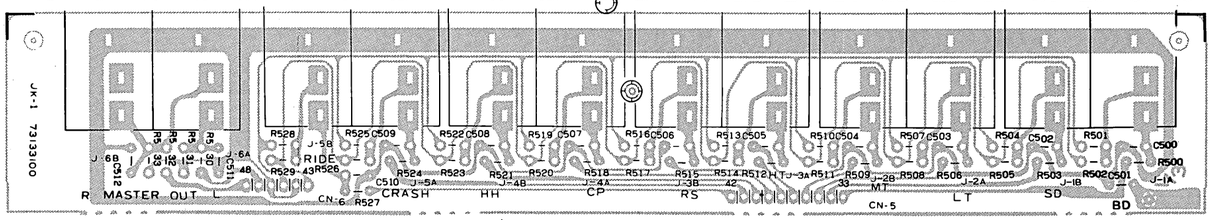


CIRCUIT DIAGRAM

VOICING BOARD VG 73133090 PCB 2291084903 3/3

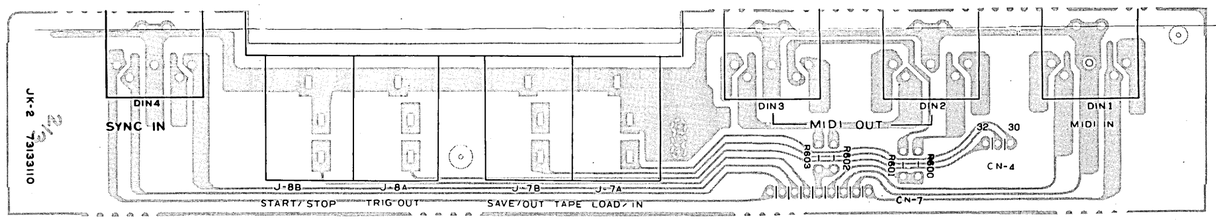


MULTI JACK BOARD
(JK-1) 73133100
(pcb 2291084900 1/3)



View from foil side

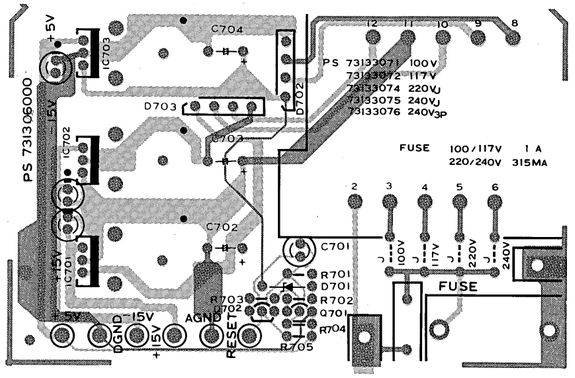
DIN JACK BOARD
(JK-2) 73133110
(pcb 2291084900 2/3)



View from foil side

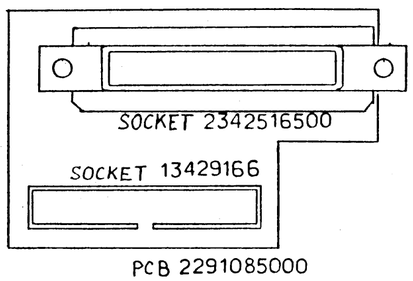
POWER SUPPLY BOARD
73133071 100V
73133072 117V
73133074 220V
73133075 240V 2P
73133076 240V 3P

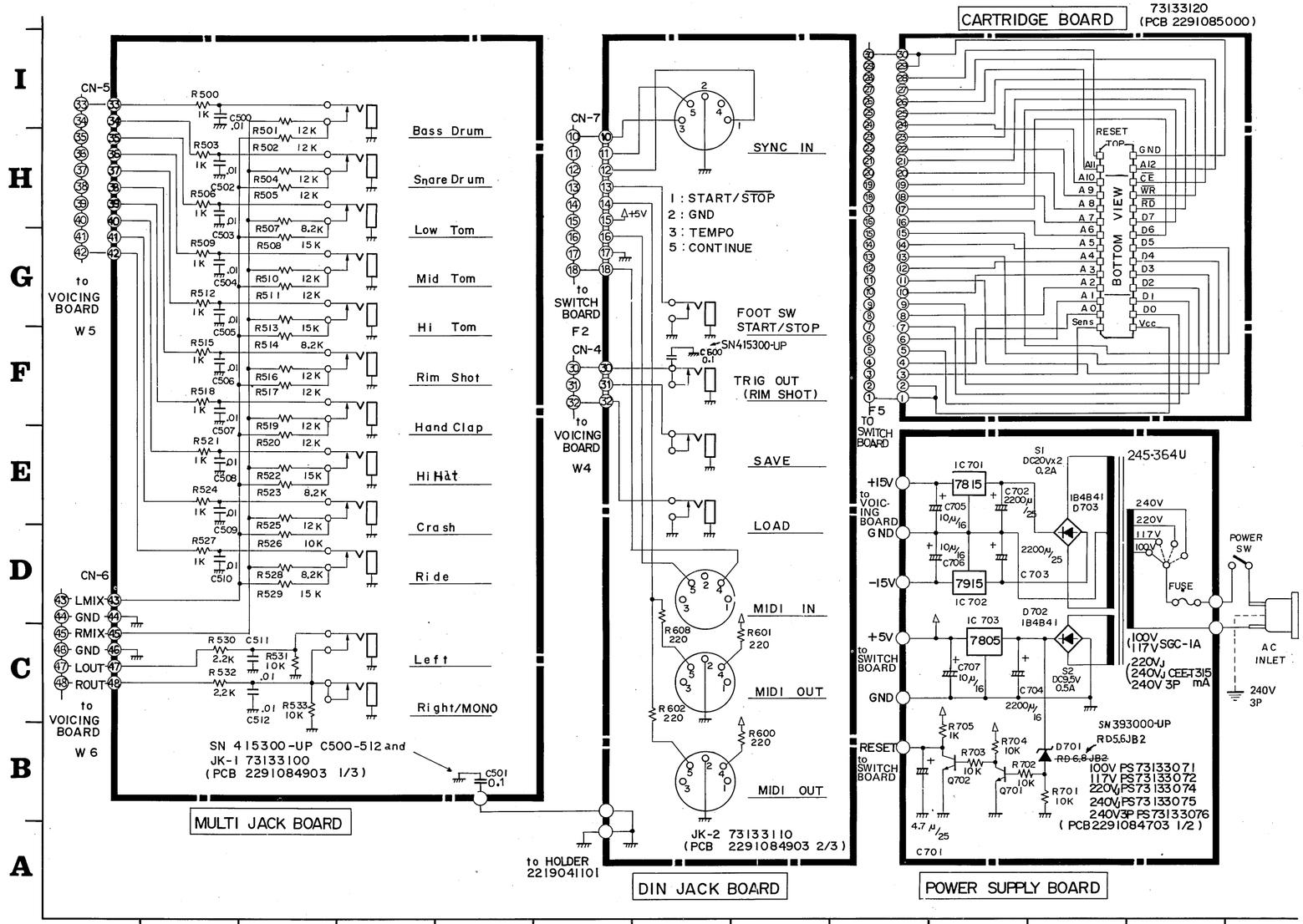
(pcb 2291084700 1/2)



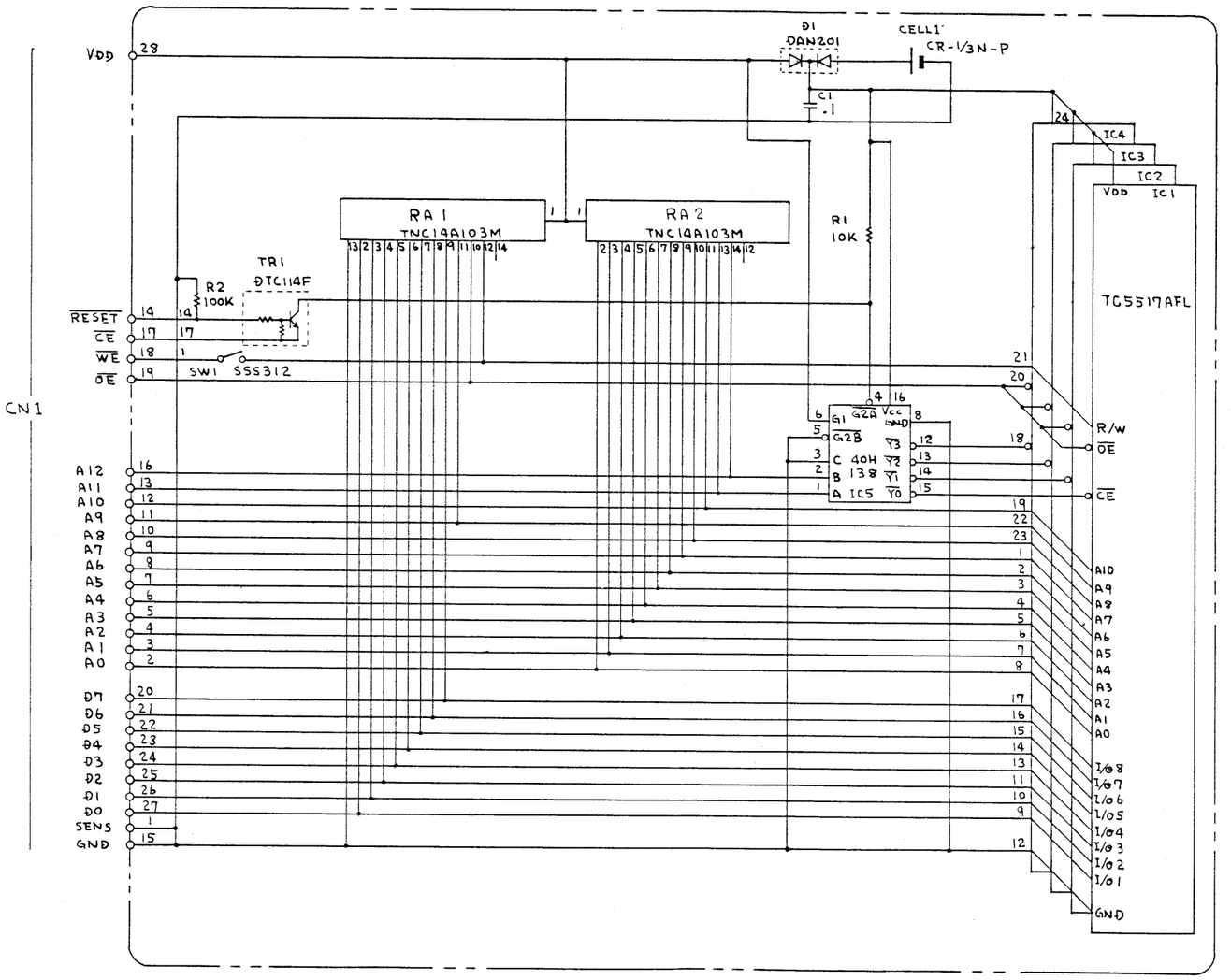
View from foil side

CARTRIDGE BOARD
73133120
(pcb 2291085000)

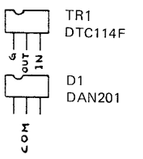


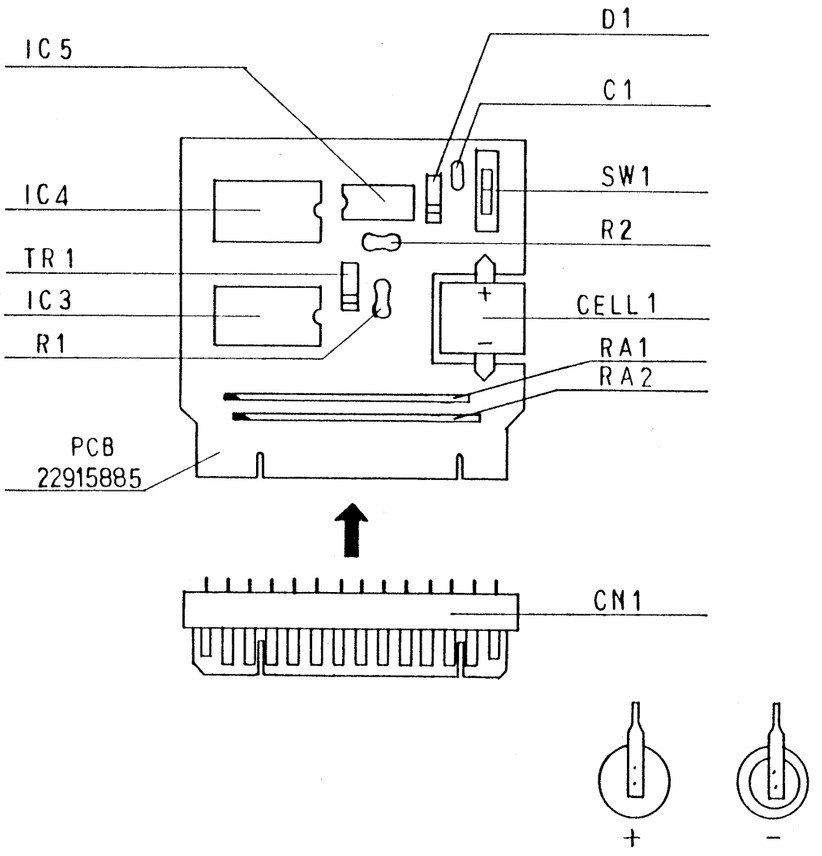


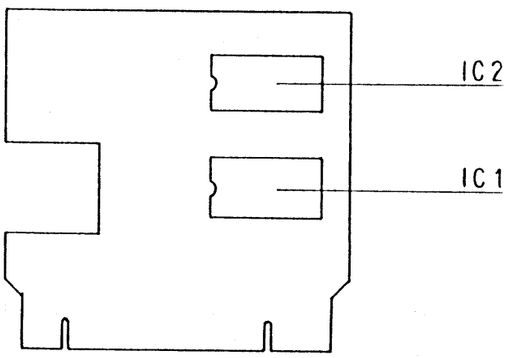
M-64C



- ICs 1-4
  TC5517AFL (16k bit STATIC RAM) (15179339)
- IC5
  40H138F (3 to 8 DECODER) (15159534)
- TR1
  DTC114F (DIGITAL TRANSISTOR) (15129150)
- D1
  DAN201 (15019138)
- SW1
  SSS312 (13159333)
- C1
  (BLOCK-LAYER CERAMIC) 1μF
- RA1, 2
  TNC14A103M (13919145)
- R1, 2
  R25J
- CELL 1
  CR-1/3N-P (12569148)
- CN1
  (23435239)







MIDI NOTES

The TR-909 is designed to accept voice messages sent over MIDI channel(s) in any of four channel modes defined in the MIDI Specification as shown in the table below.

MODE	RECEIVER
1 OMNI ON POLY	Voice messages are received from all Voice Channels and assigned to voices polyphonically.
2 OMNI ON MONO	Voice messages are received from all Voice Channels, and control only one voice, monophonically.
3 OMNI OFF POLY	Voice messages are received in Voice Channel N only, and are assigned to voices polyphonically.
4 OMNI OFF MONO	Voice messages are received in Voice Channels N thru N+M-1, and assigned monophonically to voices 1 thru M, respectively. The number of voices M is specified by the third byte of the Mono Mode Message.

N: Basic Channel

This is an inherent channel of an instrument, which cannot be changed by MIDI messages but may be changed by the panel function on the instrument.

The TR-909 has channel selections on the front panel.

To fully take advantage of this feature, however, proper Channel Mode must be selected to receive necessary voice messages only, and to reject unnecessary ones.

Before proceeding to this text, please note the following:

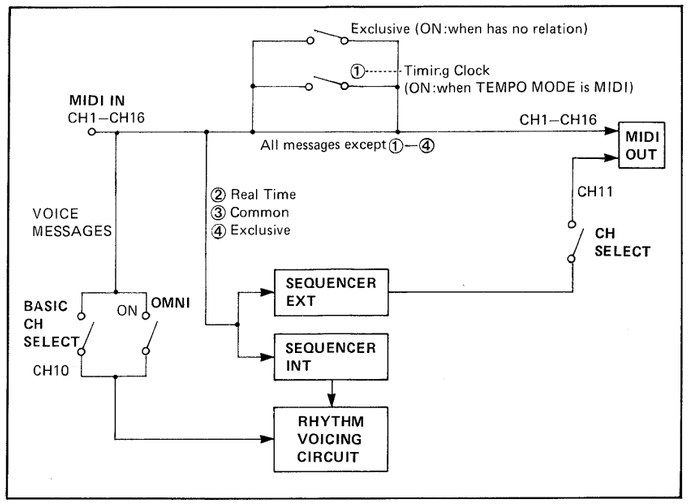
* TR-909 is a one voice rhythm machine.
* The rhythm sounds (rhythm voice generators) are assigned to KEY (NOTE) numebrs, respectively, as shown below.
* A given MIDI message will take effect only when recognized by TR-909.
* Do not put TR-909 into MIDI-loop circuit. Feedback may lead to malfunction.

MIDI KEY ASSIGNMENT

kkkkkkk=35, 36	Bass Drum
37	Rim Shot
38, 40	Snare Drum
39	Hand Clap
41, 43	Low Tom
42, 44	Closed Hi-Hat
45, 47	Mid Tom
46	Open Hi-Hat
48, 50	High Tom
49	Crash Cymbal
51	Ride Cymbal

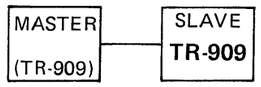
Keys not listed are ignored.
Two keys are for duplicating a sound with convenient key play.

MODES AND CHANNELS IN TR-909 MIDI CONNECTIONS



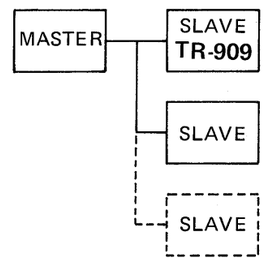
As can be seen from the diagram, TR-909 MIDO OUT does dual duties; it also serves as a kind of MIDI THRU. Using this route, additional data can be sent in different channels, and yet can be mixed with TR-909 output data in one channel at the TR-909 MIDI OUT. Thus, an external voice will be controlled both through TR-909 and by the data that TR-909 cannot provide. MIDI messages common to internal and external voices are coordinated by TR-909.
To prevent the data already applied to TR-909 from being re-fed to the subsequent unit, receiving and transmitting channels are set to different channels at the factory.

MODE 1.....OMNI ON, POLY
MODE 2.....OMNI ON, MONO



With this connection, slave unit can recognize voice messages on whichever channels the master unit transmits. There is no difference between MODEs 1 and 2 in TR-909 function since it contains only one voice.

MODE 3.....OMNI OFF, POLY



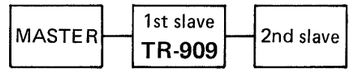
All slaves in different channels

In a system as shown, each slave should be in OMNI OFF mode with its basic channel match the channel number assigned by the master respectively. Once set, it will response to voice messages sent over its current basic channel only (see "GENERAL PRECAUTIONS" on page 16).
As for TR-909, it must be set to MODE 3. The table below will help set TR-909 to correct mode and channel.

NOTE:
Roland products with preliminary MIDI turn to OMNI OFF upon receiving POLY ON.

CHANNELS & CHANNEL MODES

	RECEIVER	TRANSMITTER
ON POWER-UP MODE CHANNEL	Defaults to MODE 1 (OMNI ON, POLY) 10 (1001)	Defaults to POLY 11 (1010)
HOW TO CHANGE CHANNELS AND MODES	Both receiving and transmitting channels can be changed to any of 16 channels from front panel. 1. Press SHUFFLE/FLAM. This will display the current channel number. On power up, without any input message, "10" will be replaced by "0" to indicate OMNI ON. 2. Holding SHUFFLE, select new channel, as necessary, by pushing MAIN KEY (1 thru 16). This also sets the new channel to MODE 3 (OMNI OFF, POLY).	1. Press LAST STEP. This will display the current channel number. 2. Holding LAST STEP, select new channel, as needed, by pushing MAIN Key (1 thru 16). This will cause transmission of OMNI OFF and POLY mode messages in the new channel. This function should be adopted when need arises to set its slave (which is incapable of changing receiving channels by itself) to OMNI OFF mode.



When the slave(s) has no capability of channel selection or mode change to OMNI OFF (like some Roland preliminary instruments), this can be cured by using the TR-909 transmitter's feature listed above.
(See "GENERAL PRECAUTIONS" on page 16.)

MODE 4.....OMNI OFF, MONO

When TR-909 receives MONO mode message with OMNI OFF mode, it recognizes the number (M) represented by the 3rd byte of the message. TR-909, then accepts voicing messages on the basic channels and upward according to M.

Example: Basic channel--4, M--3, then 4 + 3 – 1. i.e. channels 4, 5 and 6.
Result numbers exceeding 16 are ignored.

MIDI IMPLEMENTATION

(Complies with MIDI 1.0)

TRANSMITTED DATA

Status	Second	Third	Description
1001 nnnn [*1]	0kkk kkkk	0vvv vvvv	Note On kkkkkkk = 36 - 51 vvvvvvv = 64 - 96 (accent min-max) Note off vvvvvvv = 0
1011 nnnn	0ccc cccc	0vvv vvvv	Mode Message [*2] ccccccc = 124: Omni mode off 127: Poly mode on vvvvvvv = 0
1111 0010	0xxx xxxx	0yyy yyyy	Song Position Pointer [*3] xxxxxxx: Least significant yyyyyyy: Most significant
1111 0011	0sss ssss	---	Song Select [*4] sssssss: Track #
1111 1000			Timing Clock [*5]
1111 1010			Start
1111 1011			Continue
1111 1100			Stop

RECOGNIZED RECEIVE DATA

Status	Second	Third	Description
1001 mmmm [*6]	0kkk kkkk	0vvv vvvv	Note On (Trigger) kkkkkkk = 35 - 51 [*7] vvvvvvv = 1 - 127
1011 mmmm	0ccc cccc	0vvv vvvv	Mode Message ccccccc = 124: Omni mode off vvvvvvv = 0 ccccccc = 125: Omni mode on vvvvvvv = 0 ccccccc = 126: Mono mode on vvvvvvv = M [*8] ccccccc = 127: Poly mode on vvvvvvv = 0
1111 0010	0xxx xxxx	0yyy yyyy	Song Position Pointer [*9] xxxxxxx: Least significant yyyyyyy: Most significant
1111 0011	0sss ssss	---	Song Select [*10] sssssss: Track #
1111 1000			Timing Clock [*11]
1111 1010			Start
1111 1011			Continue
1111 1100			Stop
1111 1111			System Reset

All valid MIDI IN messages are transferred to MIDI OUT exept Timing Clock and System Exclusive.

While the Tape Interface is functioning (SAVE/LOAD/VERIFY), all MIDI routine is frozen.

*1 On power-up "nnnn" is set to 1010 (channel 11). Can be changed to 0000(1) through 1111(16) from the front panel.

*2 When a channel number is set, "OMNI OFF" and "POLY ON" are sent in that channel.

*3 Sent only when in TRACK PLAY and STOP modes, and after a measure number has been set.

*4 Sent when TRACK number or BANK is selected. (The same number is applied to the Memory Cartridge, if selected.)

sssssss =	0	Bank-1	Track-1
	1		Track-2
	2		Track-3
	3		Track-4
	4	Bank-2	Track-1
	5		Track-2
	6		Track-3
	7		Track-4

*5 One of the following, according to TEMPO MODE setting.

INTERNAL mode
This is synced to the internal TEMPO clock (MIDI clock and DIN SYNC Inputs are ignored).

MIDI mode
MIDI clock input is selected (Internal TEMPO clock and DIN SYNC input are ignored).

DIN SYNC mode
This is synced to the positive going edge of clock pulses from DIN jack (MIDI and Internal TEMPO clocks are ignored).

*6 The TR-909 always powers-up with channel set to "10"(1001) and with OMNI mode ON. The channel can be changed to "1"(0000) through "16"(1111) from the front panel with its mode switched to OMNI OFF.

*7 Note On message works as a trigger pulse.
Note Off message and Note On with vvvv=0 are ignored.

MIDI KEY ASSIGNMENT

kkkkkkk =	35, 36	Bass Drum
	37	Rim Shot
	38, 40	Snare Drum
	39	Hand Clap
	41, 43	Low Tom
	42, 44	Closed Hi-Hat
	45, 47	Mid Tom
	46	Open Hi-Hat
	48, 50	High Tom
	49	Crash Cymbal
	51	Ride Cymbal

NOTE:
When sounding TR-909's voices only with MIDI rhythm patterns, select a blank TRACK. Patterns programmed in a selected track will be forced to run whenever START comes from MIDI IN.

*8 Voice messages are received in Voice Channels "mmmm" through "mmmm+M-1".

*9 Recognized only when in TRACK PLAY and STOP modes.

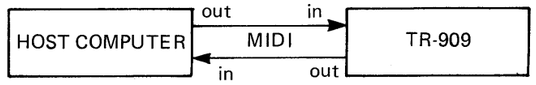
*10 Effective only when the TR-909 is in STOP during PLAY, TRACK WRITE PATTERN PLAY, or PATTERN WRITE. Upon receiving, the TR-909 enters TRACK PLAY mode.

*11 Recognized only when TEMPO MODE is set to MIDI.

TR-909 SYSTEM EXCLUSIVE

1. INTRODUCTION

Using system exclusive messages, a bank of rhythm data can be transmitted to or received from the TR-909 (TR-909 has two banks).
To interact with TR-909 by using system exclusive a host computer must be linked together.
The host computer must first send REQUEST to the TR-909 which does not take the initiative in transferring system exclusive.
The TR-909 can process the system exclusive only when in TRACK PLAY and STOP modes.



2. DATA SAVE TO THE HOST COMPUTER

(1) REQUEST HOST → TR-909

Byte	Description
1111 0000	Exclusive status
0100 0001	Roland ID #
0101 0001	Operation Code
1111 0111	EOX (End of Exclusive)

(2) DATA HOST ← TR-909

Byte	Description
1111 0000	Exclusive status
0100 0001	Roland ID #
0101 0010	Operation Code (or 0111 0000 = abort)
0000 0001	Format type
0100 nnnn	Block # (nnnn: 0000 – 1111)
0000 xxxx	
0000 yyyy	Rhythm data (yyyyxxxx) — 512 bytes
0000	
0000	
0sss ssss	Check sum (for the preceding 512 data bytes)
1111 0111	EOX
1111 0000	Exclusive status
0100 0001	Roland ID #
0101 0100	Operation Code (or 0101 0101 = no data follow)
1111 0111	EOX

(3) ACKNOWLEDGE HOST → TR-909

Byte	Description
1111 0000	Exclusive status
0100 0001	Roland ID #
0101 0011	Operation Code (or 0111 0001 = Error)
1111 0111	EOX

(4) Repeat (2) and (3) increasing Block # until nnnn = 1111.
(A bank of rhythm data is divided into 16 blocks.)

3. DATA LOAD FROM THE HOST COMPUTER

(1) REQUEST HOST → TR-909

Byte	Description
1111 0000	Exclusive status
0100 0001	Roland ID #
0101 0000	Operation Code
1111 0111	EOX (End of Exclusive)

(2) ANSWER HOST ← TR-909

Byte	Description
1111 0000	Exclusive status
0100 0001	Roland ID #
0101 0001	Operation Code (or 0111 0000 = abort)
1111 0111	EOX (End of Exclusive)

(3) DATA HOST → TR-909

Byte	Description
1111 0000	Exclusive status
0100 0001	Roland ID #
0101 0010	Operation Code
0000 0001	Format type
0100 nnnn	Block # (nnnn: 0000 – 1111)
0000 xxxx	
0000 yyyy	Rhythm data (yyyyxxxx) — 512 bytes
0000	
0000	
0sss ssss	Check sum (for the preceding 512 data bytes)
1111 0111	EOX
1111 0000	Exclusive status
0100 0001	Roland ID #
0101 0100	Operation Code (or 0101 0101 = no data follow)
1111 0111	EOX

(4) ACKNOWLEDGE HOST ← TR-909

Byte	Description
1111 0000	Exclusive status
0100 0001	Roland ID #
0101 0011	Operation Code (or 0111 0001 = Error)
1111 0111	EOX

(5) Repeat (3) and (4) increasing Block # until nnnn = 1111.
(A bank of rhythm data is divided into 16 blocks.)

GENERAL PRECAUTIONS ON MIDI CONNECTION

Although all MIDI instruments function to MIDI specification, some precautions must be taken for satisfactory operation.
This is mainly due to MIDI revision. One of primary procedures to be correctly followed is setting of "Channel Mode" otherwise MIDI function fails from the beginning. Also remember that MIDI information is effective only when receiving device can recognize a given message and has software and hardware that duplicate function defined by the message.
On power up most Roland products complying with MIDI specification 1.0 default to OMNI ON, POLY. On the contrary, they transmit OMNI OFF and POLY mode messages from MIDI OUT jack. The reason is as follows.

Receiving instrument must be reset to OMNI OFF mode when it is to accormodate voice messages sent over the channel to which it is currently assigned while other voice messages are present in other channels. (Example. a system consists of one master and more than one slave, each assigned to different channel.) However, some instruments are incapable of changing modes on the front panel and need external OMNI OFF message.

To cure this problem a system including such instruments as slaves should be configured as below.

MASTER (1st slave)	SLAVE(s)
capable of producing OMNI OFF message (or POLY, see NOTES) 1. on panel or other means at desired time 2. on power up	incapable of turning to OMNI OFF mode by itself

In the above combination:

1. Slave must be powered ON before the master is turned ON.
   (When the second slave connects to MIDI OUT of the first slave, it is the first to be turned ON.)

2. Master and Slave(s) must be set in the same channel since mode messages will be recognized by the slave only when set in the channel to which the slave's receiver has been assigned.

NOTES:

1. Roland products with preliminary MIDI turn to OMNI OFF upon receiving POLY mode ON.

2. TR-909 does not send OMNI OFF and POLY messages on power-up but on transmitting channel setting.