

Progress Report on the Development  
of the FM-type Musical Instrument  
for the period of  
May 1977 to March 1978

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March 15, 1978

Nippon Gakki Co., Ltd.

Advanced Development Division and

Electone Engineering Department

----- Summary of the current projects -----

Through this one year, TRX-project has been developed based on the result described in our last report, aiming a commercial model establishment. The general idea having been kept as it was, some changes in its specifications have occurred including the introduction of "After Touch Control".

The preparation of LSI implementation is completed before March, 1978. Stanford University will receive another official report from Yamaha on MOS chips by the end of March, 1978.

The details are reported in the next paragraph.

While, in MAD-project no major changes of design in the experimental organ were made since May, 1977.

Most of the bugs resided in the system have been overcome.

Only persistent one that we have to insecticide is a memory failure of very intermittent nature, and it will be solved soon.

As for software part of the project, we are still trying to find good tone parameters to let MAD sound better. However, it seems that time is getting ripe for us to think about more realistic and optimized design of new electronic organ, based upon the knowhow obtained through the development of MAD.

1. New effect "After Touch Control"

The principle of After Touch Control is to introduce a new musically significant capability to TRX type keyboard instrument.

As a trade strategy, it was required that the first TRX commercial model should have some new feature apart from its FM tone quality to make more clear distinction from the electronic piano type instrument which several important makers have put on the market these years. In other words, to have a better sale, our first model should not be an improvement of the electronic piano, but rather be a new attractive type of keyboard instrument.

With After Touch Control effect, an organ player can modify his tone any time after key depression as long as his finger is held on the key. He can control tone volume, vibrato rate or vibrato depth etc. through the finger pressure, for instance, he can intentionally change a decaying tone into a sustained tone when tone volume is selected to be controlled.

To implement After Touch Control, the touch pressure sensing device containing piezo-resistive semi-conductor is placed underneath every key piece, as shown in Fig. 1. Its reliability is on our investigation stage, and very promising data have been obtained.

2-1. TRX-X4

Started in April, 1977 and completed in July, 1977.

After Touch Control was introduced after many experiments on pressure sensor devices and other general specifications. The tone generation hardware of TRX-3 (in our last report) was basically appropriated.

Several keyboard players tried TRX-X4 with After Touch Control to investigate its utility in music.

Yamaha's evaluation on it was in the affirmative.

2-2. TRX-X5

Started in May, 1977 and completed in October, 1977.

(After Touch Control was added in January, 1978)

This is a prototype for combo-use. The TRX tone generation circuit was generally adopted even with several modifications. The tone parameters were selected so as to agree with combo band popular music.

To realize a good portability, it has 76 keys instead of 88 keys and the cabinet was designed to reduce weight substantially with the idea of detachable four legs.

Plastic and metal made key parts were installed instead of wooden material for cost reduction.

Other specifications are in Table 2.

2-3. TRX-X6

Started in July, 1977 and completed in October, 1977.

A high quality stage model was herewith aimed at.

Four "one carry-one modulation" FM equations were adopted to obtain better sound. Minor change was also made in cabinet decoration design. The detailed specifications are almost identical to Table 3. explained in the next paragraph. To realize more efficient control of the increased number of tone parameters, we prepared an especially designed "Tone Parameter Controller" for TRX-X6. Each of the envelope data, pitch data, touch data can be controlled directly by the sliding knob, as seen in Feb. 2. Any temporal state of the whole sliding knob position can be memorized if the button MI or MII is pressed.

With the above-described prototypes, the developmental work was succeeded in November, 1977 by Electone Engineering Department which specifies every designing of Yamaha electronic musical instrument and promotes to start new model production.

### 3. Commercial model establishment

Since November, 1977 and currently going on.

Yamaha's enterprising evaluation on TRX was again proceeded with the prototypes furnished from Advanced Development Department. It was made from various aspects including future market survey so that Yamaha might have good success in whole TRX series products.

Our conclusion was that we should start with a high quality model giving the market an initial impressive image. Therefore, TRX-1, having the major specifications of Table 3 and LSI-Chip-Layout of Fig. 3, was chosen as the first commercial model.

Most of the important parts have already been designed for production (or pre-production) including the printed circuit boards, the enclosure circuits of LSIs, the major parts of cabinet etc. Audio amplifier and loud speaker are on refining stage.

All necessary LSIs are listed in Table 3, being now ready to use in the instrument. Due to After Touch Control Introduction, TRX now requires 13 kinds of LSIs instead of 11 kinds stated in our last report.

The prototype applying such production (or pre-production) parts will be built by May, 1978.

MOS-LSI table (13 kinds)

No.	Symbol	function	# of pins
311	KC	key assignment	40
312	CP	key assignment	40
313	FRM	storage of frequency #	40
321	EG	envelope signal generation	40
322	EC		48
314	PG	phase accumulation	40
315	OP	sine table and log to linear conversion	48
320	IG	initial touch response signal generation	24
316	ACC	accumulation of 16 channels	24
327	ADD	serial addition	24
323	VRG	voice data storage	40
318	MPX	analog data multiplexing	40
319	AG	after touch response signal generation	40

Table 1.



TRX-X5 Specifications

# of keys	76 (E-G)
6 preset voices	Piano I, Piano II, Vib., Harpsichord I, Harpsichord II, Lute
Control knob	volume control, tremolo speed control, tremolo sw., tone bright/soft sw., detune on/off sw., power sw.
Optional Foot-Control	1. Damper pedal 2. Tremolo pedal

----- technical data -----

FM equation	two "one carry - one modulation"s
# of channels	16
Data domain	log.
Voice data storage	standard PROM
DAC sampling rate	85 $\mu$ s
Clock	1.1 MHz
# of LSIs	27 chips 32 chips (with After Touch Control)

TRX-1 specifications

Keyboard	88 keys (A-C) wooden key piece, mass-reaction mechanism																
Preset Voice	<table> <tr> <td>1. Piano I</td><td>9. Marimba I</td></tr> <tr> <td>2. Piano II</td><td>10. Marimba II</td></tr> <tr> <td>3. Electric Piano I</td><td>11. Vibe. I</td></tr> <tr> <td>4. Electric Piano II</td><td>12. Vibe. II</td></tr> <tr> <td>5. Harpsichord I</td><td>13. Custom I</td></tr> <tr> <td>6. Harpsichord II</td><td>14. Custom II</td></tr> <tr> <td>7. Lute I</td><td>15. Custom III</td></tr> <tr> <td>8. Lute II</td><td>16. (User's Area)</td></tr> </table>	1. Piano I	9. Marimba I	2. Piano II	10. Marimba II	3. Electric Piano I	11. Vibe. I	4. Electric Piano II	12. Vibe. II	5. Harpsichord I	13. Custom I	6. Harpsichord II	14. Custom II	7. Lute I	15. Custom III	8. Lute II	16. (User's Area)
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Foot-Pedal	Left - Vibrato Middle - Tremolo Right - Damper																
Control knob	Power Switch Volume Control Pitch Control Tremolo Speed Control Vibrato Speed Control																
Touch Response	Initial Touch Control After Touch Control																

---- technical data ----

FM equation	four "one carry - one modulation"s
# of channels	16
Data format	11 bit parallel
Data domain	log.
SIN	log. table look up
Voice data storage	standard PROM
DAC rate	85 $\mu$ S
Clock	1.1 MHz
# of LSIs	55
# of Voice ROMs	32